

U.S. POLYMERIC

HITCO MATERIALS DIVISION

(NASA-CR-179416) STATISTICAL
CHARACTERIZATION OF CARBON ELECTRIC PREFREG
MATERIALS, VOLUME 1 Final Report (HITCC)
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FINAL REPORT
VOLUME I

**STATISTICAL CHARACTERIZATION OF
CARBON PHENOLIC PREPREG MATERIALS**

NAS8-36298

COPY # 9

INTRODUCTION AND SUMMARY

NAS8-36298

I. INTRODUCTION AND BACKGROUND

In January 1985, a Request for Proposal was issued from NASA, George C. Marshall Space Flight Center, entitled "Statistical Characterization of Carbon Phenolic Prepreg Materials". The objective of this work was to ...characterize several lots of materials used for carbon/carbon and carbon/phenolic product manufacture. The justification for this study was ...lack of material and process control and/or properly controlled processes that are not optimized has resulted in excessive rejection rates, variation in material properties, and unpredictable performance.

The approach was to select two carbon/phenolic systems to fabricate carbon/phenolic throat and exit cone materials, one of which would be U.S. Polymeric's prepreg, FM 5055B. The alternate material was finally selected to be FM 5834 which contains a spun PAN fabric, STACKPOLE FIBERS SWB-8, as a replacement for HITCO's CCA-3 rayon based fabric. The other raw materials were identical to FM 5055B.

For the carbon/carbon prepgs to fabricate 2-D exit cones, one was to be U.S. Polymeric's prepreg, FM 5064J, which contain AMOCO (formerly Union Carbide) WCA graphite cloth. The alternative material was finally selected to be FM 5839 which contains STACKPOLE FIBERS PWB-6, with other raw materials being identical. A raw material tree showing the commonality of raw materials is shown on table 1, page #5.

Initially, the concept was to produce 1,100 lbs. of each prepreg type with 800 lbs. of each prepreg being delivered to fabricators (total = 3200 lbs.). As the fabrication and component evaluation evolved, the requirements for

varying amounts of prepreg for each type and each lot were promulgated totaling 3,838 pounds for delivery to the fabricators. To maintain the concept of a specified minimum of five lots, 20-pound prepreg test lots were utilized using different raw material vendor lots. These test lots were halved and subjected to evaluations identical to the delivered prepgs. A breakout of the lot size required for each prepreg is also included on table 1, page #5.

Production occurred randomly over the period from April 30, 1986 to July 25, 1986, generally controlled by the availability of raw material lots. Production was not conducted in lot number sequence but where prepgs required only fabric changes, the production was scheduled to efficiently utilize the common filler and resin mix.

The final report for this contract is organized in several volumes. Volume I is broken down into testing categories based on raw material or product form. Each category contains a discussion of the sampling plan, comments and observations on each test method utilized and a summary of the results obtained for each category. The numerical data is initially presented in a comparative data format, where results from the same test are tabulated for each raw material or prepreg type. The comparative data includes averages, sample standard deviations, and a maximum and minimum value for each category. Next, the individual sample data is presented for each lot, with raw materials being designated with a lot number and sample number (i.e., 4-2E) which would indicate Lot #4, sample #2 from the end of a fabric roll. Prepreg test results are designated by NASA lot number, by treater lot number, and roll number (i.e., Lot #2 D09280-S1). Finally, the data is summarized by NASA lot number, and the grand average and standard deviation determined for each category. A calculation of the "A Basis" minimum and "A Basis" maximum is included and determined using factors from Table 9.6.4.1 in MIL-HDBK-5D for one sided tolerance limits, normal distribution, 0.95 confidence level, sample standard deviations ($n-1$), and $P=.99$ for "A allowables".

Volume II contains proposed specifications and copies of all U.S. Polymeric test methods utilized under this contract. ASTM and MIL-STD test methods have not been included.

The eleven fingerprint test data report books include individual test determinations and have been organized by prepreg type and NASA lot number and include all the raw material test data for the filler, resin and fabric included in that lot of prepreg. Also included are the graphical results obtained for each sample where applicable.

II. SUMMARY AND CONCLUSIONS

- a. Specifications have been proposed for prepgs and raw materials and are included in Volume II along with the USP test methods.
- b. The variation of spun PAN fabrics compared to continuous rayon fabrics leads to wider raw material and prepreg specifications for the spun PAN fabrics.
- c. Filler lot-to-lot variations in USP 28 high purity carbon black are minor, and it does not appear significant enough to affect final performance of the prepgs.
- d. Some of the tests conducted such as pH, Chang's Index, and GPC are limited in their ability to distinguish the subtle differences in the two phenolic resins utilized in the study.
- e. Some tests, such as the profile of the NMR and TGA curves, are able to distinguish the differences between 91LD and USP 39A resin.
- f. Traceability of resin variations has been demonstrated by the high sodium levels in Lot #4 of USP 39A resin which showed up in both the FM 5064J and FM 5839 prepgs in Lot #4.

- g. High variability of spun PAN fabrics include areal weight, intra-roll variations, thread counts, breaking strengths, and TGA. Variations of spun PAN physical data are generally 3-4 times that shown by continuous rayon fabrics.
- h. The cured panel strength of spun PAN fabrics show higher standard deviations than continuous rayon but only by a factor of 2.
- i. The most significant ultimate strength value observed in the study is the 56,000 psi compressive strength of CCA-3 prepeg, FM 5055B.
- j. The flexural strength of spun PAN prepgs shows improvement over their continuous rayon counterparts.
- k. Residual volatiles are primarily influenced by resin content and resin selection rather than by volatile levels in the prepeg.

TABLE I

MATERIALS USED

FILLER
**USP-28 FILLER
(CARBON BLACK)**

FILLERRESIN

91 LD
(PHENYLFORMALDEHYDE)

<u>FABRIC</u>	<u>SWB-8</u>	<u>CCA-3</u>	<u>USP-39A</u> (PHENYLALDEHYDE)	<u>MCA</u>
Supplier	STACKPOLE Fibers	HITCO Materials	STACKPOLE Fibers	UNION CARBIDE
Fiber Type	Spun Yarn	Continuous Fiber	Spun Yarn	Continuous Fiber
Precursor	PAN	Rayon	PAN	Rayon
Weave Type	8 Harness Satin	Plain Weave	Plain Weave	Plain Weave
Count	(38 x 38)	(50 x 48)	(28 x 28)	(29 x 21)
Weight	8.5 oz/yd ²	8.0 oz/yd ²	6.0 oz/yd ²	7.2 oz/yd ²
<u>PREPREG</u>	<u>FM 5834</u>	<u>FM 5055B</u>	<u>FM 5839</u>	<u>FM 5064J</u>
				<u>HITCO</u>
Lot 1	---	*	844	204
Lot 2	300	*	844	44
Lot 3	---	*	790	---
Lot 4	---	*	---	196
Lot 5	---	*	---	85
				<u>KAISER</u>

				*
				24
				299
				53
				87

* 20-POUND TEST LOT FOR USP EVALUATION ONLY.

TABLE OF CONTENTS

FILLER TESTING

NAS8-36298

U.S. Polymeric O.E. 71108

	<u>PAGE</u>
I. SAMPLING PLAN.....	1
II. TEST METHODS AND OBSERVATIONS.....	1
A. Carbon Assay.....	1
B. Ash Content.....	2
C. pH.....	2
D. Particle Size.....	2
E. Thermogravimetric Analysis (TGA).....	3
F. Atomic Absorption of Alkaline Metals.....	4
III. SUMMARY.....	4

TABLES AND CHARTS

Average Test Results and Statistical Summary.....	5
Typical Horiba Printout.....	7
Typical TGA Curve.....	8
TGA Correlation Chart.....	10

USP-28 FILLER TESTING
COMMENTS AND OBSERVATIONS

NAS8-36298

I. SAMPLING PLAN

USP-28 Filler is a designation for a proprietary, high purity, dry powdered carbon black used with phenolic resin systems. It is packaged in 50-pound paper bags, 1,500 pounds per pallet. For this project, five lots were selected; each manufacturer's lot is identified with a date code so that the manufacturing date can be determined.

For Lot #1 on this NASA contract, 4,500 pounds or 3 pallets of USP-28 were isolated. For Lots #2 through #5, 500 pounds each were isolated. Sampling was done from three separate 50-pound bags of each lot and the average values were used to represent that lot for comparative purposes in this report. The initial samples for Lot #2, 3 and 5 did not meet the criteria for sodium levels for FM5055B, therefore different lots were sampled from available in-house material and designated as Lots #2A, 3A, and 5A.

USP-28 Filler samples were maintained in closed plastic containers until the time of testing. Tabulated data is given on pages #5 and #6.

II. TEST METHODS AND OBSERVATIONS

A. Carbon Assay

A LECO model CHN-600 analyzer was used to determine the carbon assay at the Gardena facility. With the exception of Lot #4 which varied from 99.17% to 99.75%, all samples exceeded 99.0% in carbon content and were relatively consistent within each lot. (See data on page #5)

B. Ash Content

To determine ash content, a 2-gram sample was pyrolyzed at 950°C (1,750°F) for a minimum of four hours. The values reported are the average of two determinations of ash content.

C. pH

ASTM D-1512 method A, the boiling water slurry method, was used to determine pH. Again, the values reported are an average of 2 determinations. It is estimated that a less pure carbon black filler would have a pH in the range of 8 to 9, but removal of trace oil and contamination puts the USP-28 high purity filler in the 4 to 6 pH level.

D. Particle Size

Particle size was determined by two methods: in the first, a scanning electron microscope (SEM) was used for a visual sampling and measurement at 20,000X magnification. The minimum and maximum particle size observed was recorded and a representative sample (10-20) individual particles spanning the size range were measured. The average particle size by SEM was the arithmetic average of that small sample.

The second method for determining particle size was a HORIBA analyzer. The HORIBA light scattering centrifugal particle analyzer operates on the principle of light absorbance of a liquid dispersion of carbon black in an ethylene glycol slurry. A 2-mg sample of carbon black was initially used, and the print-out includes a particle size distribution graph. A typical print-out for duplicate runs of the same sample is attached as page #7. Individual sample results are included in each of the appropriate prepreg lot

fingerprints. It should be noted that the HORIBA analyzer gives an average particle size from 150% to 250% of the value observed in the small visual sample under the scanning electron microscope.

E. Thermogravimetric Analysis (TGA)

Two different equipment set-ups were used to determine the weight loss on heating. Lots #1 and #4 were run by Beckman Industrial Labs using an OMNITHERM data system. The temperature at which 50% weight loss occurred averaged about 723°C (1333°F) using this equipment set-up. Lots #2A, 3A, and 5A were run at U.S. Polymeric using a Perkin-Elmer model TGS-2 thermal analyzer, controlled by Perkin-Elmer System IV controller. The temperature at 50% weight loss using USP equipment averaged 858°C (1576°F). This emphasizes the need to use identically calibrated equipment on any comparative thermal test. Typical examples of both TGA curves are included on pages #8 and #9. Individual sample TGA curves are included in each of the appropriate prepeg lot fingerprints.

As a sidelight, a correlation of the slope of the TGA curve in the steep section, measured in percent weight loss per °C, was made to the sample size in milligrams. For both equipment set-ups, a relatively high value for the correlation coefficient (r^2) was obtained. A (r^2) value of 1 indicates a perfect linear relationship while a (r^2) of 0 indicates that no relationship exists. For U.S. Polymeric equipment, the correlation of the slope of the TGA curve and the sample size in mg had a (r^2) value of 0.89 while for Beckman, the value of (r^2) was 0.81. The chart showing these relationships is included on page #10. This indicates that the steepness of the TGA curve is dependent on the sample size used.

F. Atomic Absorption of Alkaline Metals

The ash from a 600°C (1,112°F) pyrolysis for 16 to 20 hours was digested with hydrochloric acid and compared for light absorption with accurately prepared alkaline metal standards at 0.5 ppm. The atomic absorption data show some minor lot variations but good reproducibility between samples in a lot. It was noted that Lot #5, Samples 5A-1 through 5A-3 had the highest sodium levels (18-19 ppm) and was also highest in pH (5.5), but this correlation of sodium content and pH did not hold for the other lots.

Additional data was also generated from the test method for atomic absorption (page #6). Moisture content of the carbon black was determined by heating 2 grams at 125°C (257°F) for two hours and an ash content was determined by heating at 600°C (1,112°F) for 16-20 hours. The data shows good agreement of the overall averages for ash content between the two test methods but does not hold consistent on a lot-to-lot basis.

III. SUMMARY

The data is typical for USP-28 high purity carbon black and exhibits only minor lot-to-lot variations. It does not appear that the lot-to-lot variation is significant enough to affect the final performance of the prepgs.

USP-28 FILLER TEST DATA
AVERAGE TEST RESULTS

Page #5

NAS8-36298

SAMPLE NUMBER	CARBON ASSAY	ASH CONTENT	PH units	MAXIMUM		MINIMUM		AVERAGE		HORIBA PART. SIZE S.E.M	TEMP. °C	T.G.A. CTM-51
				PART. SIZE	microns	PART. SIZE	microns	PART. SIZE	microns			
				S.E.M	S.E.M	S.E.M	S.E.M	S.E.M	S.E.M			
METHOD QAI-5560	PTM-71B	ASTM D1512								CTM-72		
#1 - 1	99.17	0.007	4.88	0.65	0.22	0.45	0.86	0.45	0.45	0.86	750	
#1 - 2	99.10	0.007	4.88	0.62	0.17	0.36	0.92	0.36	0.36	0.92	751	
#1 - 3	99.12	0.003	5.00	0.85	0.22	0.38	0.94	0.22	0.22	0.94	749	
#2A-1	99.31	0.000	4.60	0.90	0.23	0.56	0.86	0.23	0.23	0.86	842	
#2A-2	99.18	0.000	4.50	1.25	0.20	0.57	1.02	0.20	0.20	1.02	850	
#2A-3	99.40	0.000	4.60	1.17	0.25	0.52	0.94	0.25	0.25	0.94	857	
#3A-1	99.40	0.000	4.88	0.99	0.20	0.51	0.92	0.20	0.20	0.92	864	
#3A-2	99.32	0.000	4.78	0.88	0.18	0.51	0.88	0.18	0.18	0.88	860	
#3A-3	99.44	0.002	4.82	0.85	0.15	0.42	0.88	0.15	0.15	0.88	850	
#4 - 1	99.75	0.013	4.75	0.56	0.20	0.42	0.94	0.20	0.20	0.94	701	
#4 - 2	99.57	0.008	4.82	0.73	0.20	0.38	0.80	0.20	0.20	0.80	688	
#4 - 3	99.17	0.008	4.72	0.70	0.23	0.43	0.94	0.23	0.23	0.94	697	
#5A-1	99.27	0.000	5.32	0.99	0.16	0.50	0.95	0.16	0.16	0.95	837	
#5A-2	99.36	0.008	5.52	0.79	0.20	0.45	0.89	0.20	0.20	0.89	870	
#5A-3	99.28	0.012	5.58	0.88	0.20	0.50	1.03	0.20	0.20	1.03	880	

USP-28 GRAND TOTAL	CARBON ASSAY	ASH CONTENT	PH units	MAXIMUM		MINIMUM		AVERAGE		HORIBA PART. SIZE S.E.M	TEMP. °C	T.G.A. CTM-51
				PART. SIZE	microns	PART. SIZE	microns	PART. SIZE	microns			
				S.E.M	S.E.M	S.E.M	S.E.M	S.E.M	S.E.M			
AVERAGE	99.32	0.005	4.91	0.85	0.20	0.46	0.92	0.20	0.20	0.92	803	
STD DEV	0.18	0.005	0.32	0.19	0.03	0.07	0.06	0.03	0.03	0.06	71	
MINIMUM	99.10	0.000	4.50	0.56	0.15	0.36	0.80	0.15	0.15	0.80	688	
MAXIMUM	99.75	0.013	5.58	1.25	0.25	0.57	1.03	0.25	0.25	1.03	880	

USP-28 FILLER
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	CARBON ASSAY	ASH CONTENT	PH units	MAXIMUM		MINIMUM		AVERAGE		HORIBA PART. SIZE S.E.M	TEMP. °C	T.G.A. CTM-51
				PART. SIZE	microns	PART. SIZE	microns	PART. SIZE	microns			
				S.E.M	S.E.M	S.E.M	S.E.M	S.E.M	S.E.M			
LOT #1	99.13	0.006	4.92	0.71	0.20	0.40	0.91	0.20	0.20	0.91	750	
LOT #2	99.30	0.000	4.57	1.11	0.23	0.55	0.94	0.23	0.23	0.94	850	
LOT #3	99.39	0.001	4.83	0.91	0.18	0.48	0.89	0.18	0.18	0.89	858	
LOT #4	99.50	0.010	4.76	0.66	0.21	0.41	0.89	0.21	0.21	0.89	695	
LOT #5	99.30	0.007	5.47	0.89	0.19	0.48	0.96	0.19	0.19	0.96	862	

GRAND AVG.	99.32	0.005	4.91	0.85	0.20	0.46	0.92	0.20	0.20	0.92	803	
STD DEV	0.18	0.005	0.32	0.19	0.03	0.07	0.06	0.03	0.03	0.06	71	
COUNT	15	15	15	15	15	15	15	15	15	15	15	
<u>A BASIS</u>												
FACTOR	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520	
MINIMUM	98.70	-0.012	3.78	0.17	0.10	0.23	0.71	0.10	0.10	0.71	553	
MAXIMUM	99.94	0.021	6.04	1.53	0.30	0.70	1.13	0.30	0.30	1.13	1053	

USP-28 FILLER TEST DATA
AVERAGE TEST RESULTS

Page #6

NAS8-36298

SAMPLE NUMBER	ATOMIC ABSORPTION OF ALKALINE METALS					MOISTURE	ASH	
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm	CONTENT %	CONTENT %
METHOD	-----CTM 53B-----					-----CTM 53B-----		
#1 - 1	3.0	1.5	0.0	0.5	0.0	5.0	0.010	0.000
#1 - 2	2.0	0.0	0.0	0.0	0.0	2.0	0.008	0.000
#1 - 3	1.5	0.0	0.0	0.0	0.0	1.5	0.005	0.003
#2A-1	7.0	1.5	2.5	0.0	0.0	11.0	0.036	0.003
#2A-2	7.5	1.0	1.5	0.0	0.0	10.0	0.027	0.013
#2A-3	9.0	2.5	2.0	0.0	0.0	13.5	0.042	0.008
#3A-1	6.0	2.5	2.5	0.0	0.0	11.0	0.008	0.025
#3A-2	6.0	1.0	2.5	0.0	0.0	9.5	0.018	0.005
#3A-3	6.0	2.0	2.0	0.0	0.0	10.0	0.000	0.000
#4 - 1	2.0	1.5	1.5	1.0	0.0	6.0	0.024	0.003
#4 - 2	2.0	2.0	0.5	1.0	0.0	5.5	0.010	0.005
#4 - 3	1.0	1.0	1.5	0.0	0.0	3.5	0.013	0.000
#5A-1	18.5	2.0	2.0	0.0	0.0	22.5	0.016	0.008
#5A-2	18.0	2.0	2.0	0.0	0.0	22.0	0.000	0.013
#5A-3	19.0	2.5	2.0	0.0	0.0	23.5	0.000	0.018

USP-28								
GRAND	ATOMIC ABSORPTION OF ALKALINE METALS					MOISTURE	ASH	
TOTAL	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm	CONTENT %	CONTENT %
AVERAGE	7.2	1.5	1.5	0.2	0.0	10.4	0.014	0.007
STD DEV	6.3	0.8	0.9	0.4	0.0	7.2	0.013	0.007
MINIMUM	1.0	0.0	0.0	0.0	0.0	1.5	0.000	0.000
MAXIMUM	19.0	2.5	2.5	1.0	0.0	23.5	0.042	0.025

USP-28 FILLER
LOT AVERAGES AND STATISTICAL SUMMARY

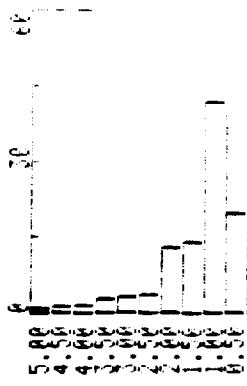
NAS8-36298

LOT AVERAGES	ATOMIC ABSORPTION OF ALKALINE METALS					MOISTURE	ASH	
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm	CONTENT %	CONTENT %
LOT #1	2.2	0.5	0.0	0.2	0.0	2.8	0.008	0.001
LOT #2	7.8	1.7	2.0	0.0	0.0	11.5	0.035	0.008
LOT #3	6.0	1.8	2.3	0.0	0.0	10.2	0.008	0.010
LOT #4	1.7	1.5	1.2	0.7	0.0	5.0	0.016	0.003
LOT #5	18.5	2.2	2.0	0.0	0.0	22.7	0.005	0.013

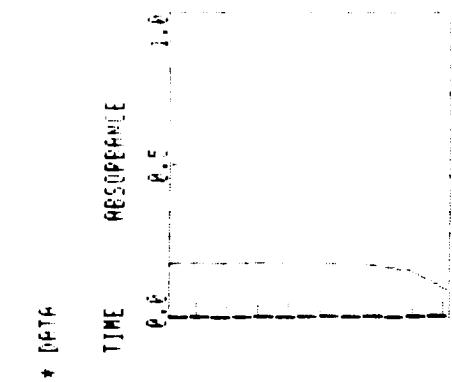
GRAND AVG.	7.2	1.5	1.5	0.2	0.0	10.4	0.014	0.007
STD DEV	6.3	0.8	0.9	0.4	0.0	7.2	0.013	0.007
COUNT	15	15	15	15	15	15	15	15

<u>A BASIS</u>	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520
FACTOR	-15.0	-1.3	-1.8	-1.1	0.0	-15.1	-0.031	-0.019
MINIMUM	29.5	4.4	4.8	1.4	0.0	35.9	0.060	0.033

Sample #2
Lot #1-1



* DISTRIBUTION GPPH FOR LOT #1-1.



* TIME 0.00-1.00, 0.50-1.00,

SPEED 5000, FREQ.

(DUE) 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

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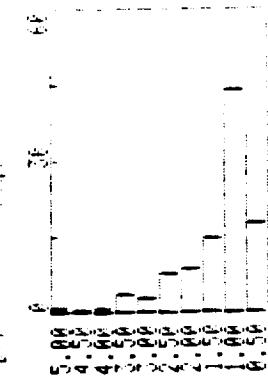
0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

* DISTRIBUTION GPPH FOR LOT #1-1.

Sample #1
Lot #1-1



ORIGINAL PAGE IS
OF POOR QUALITY

* TIME 0.00-1.00, 0.50-1.00,
SPEED 5000, FREQ.

(DUE) 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

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0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

0.50, 0.50, 0.50, 0.50

* DISTRIBUTION GPPH FOR LOT #1-1.

* DISTRIBUTION GPPH FOR LOT #1-1.

HOLDING (400-500)
PICKUP (400-500)

C=0.013 mg/ml
SAMPLE TESTED

#2

DATE 5-22-86

SAMPLE NASA-LT#1

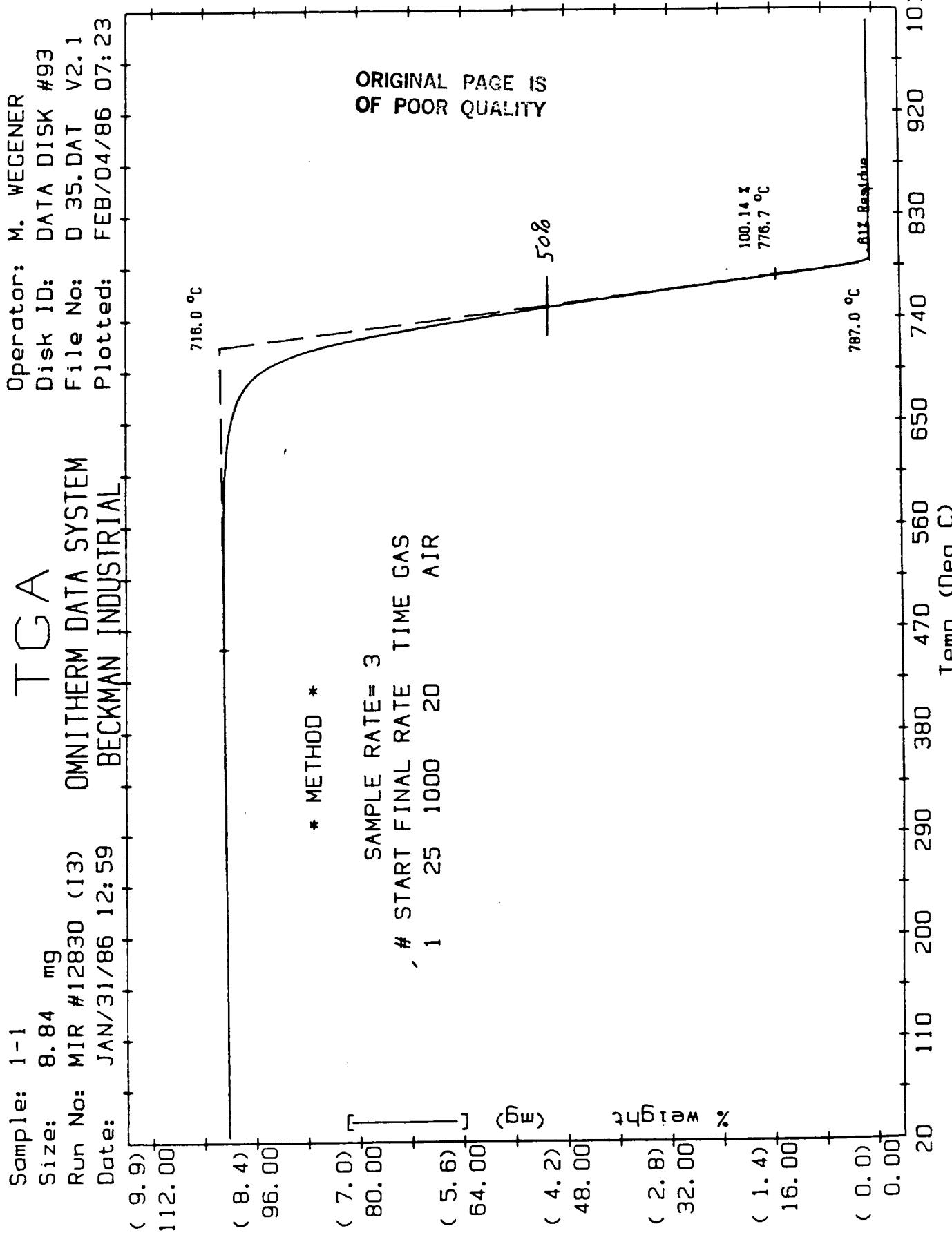
C=0.013 mg/ml
SAMPLE TESTED

#1

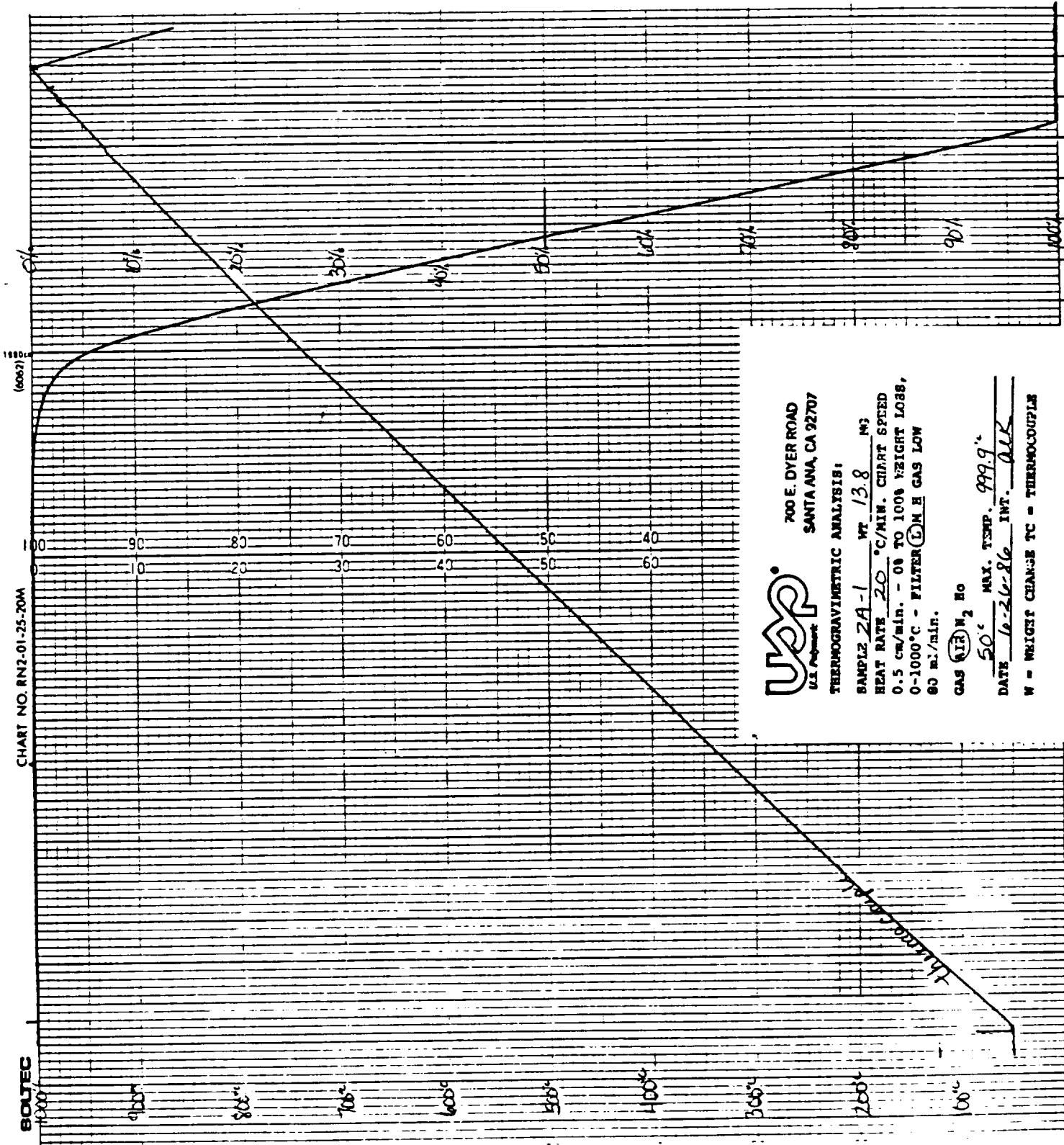
DATE 5-22-86

SAMPLE NASA-LT#1

C=0.013 mg/ml
SAMPLE TESTED



ORIGINAL PAGE IS
OF POOR QUALITY



USP 28 FILLER T.G.A. CORRELATIONS

SLOPE VS. SAMPLE SIZE

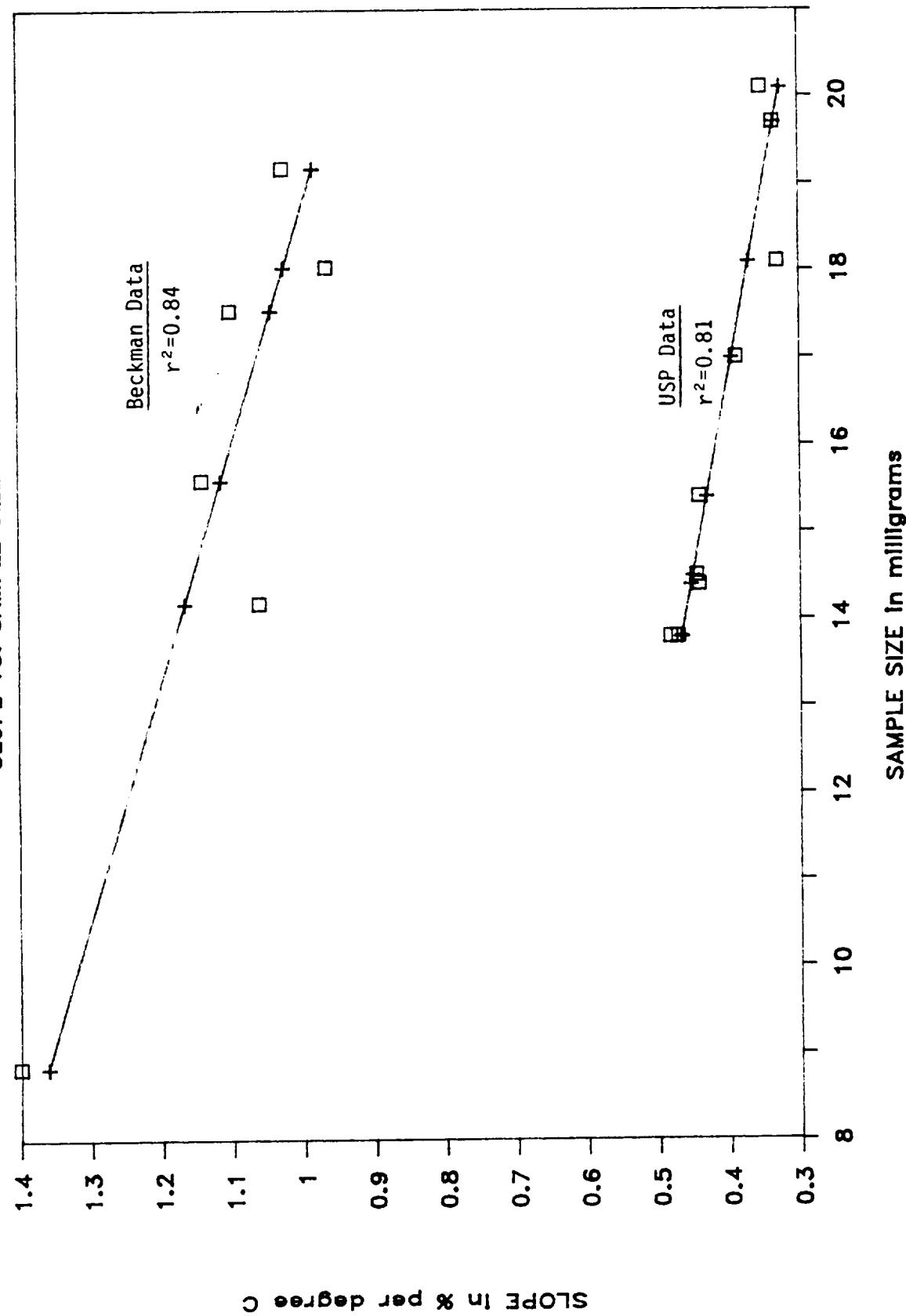


TABLE OF CONTENTS

RESIN TESTING

NAS8-36298

U.S. Polymeric O.E. 71108

	<u>PAGE</u>
I. SAMPLING PLAN.....	1
II. TEST METHODS AND OBSERVATIONS.....	2
A. Resin Solids.....	2
B. Specific Gravity.....	2
C. Brookfield Viscosity.....	2
D. Gel Time.....	2
E. Atomic Absorption.....	3
F. Differential Scanning Calorimetry (DSC).....	3
G. Phenol Content.....	4
H. Rheometric Dynamic Spectrometry (RDS).....	4
I. pH.....	4
J. Chang's Index.....	5
K. Thermogravimetric Analysis (TGA).....	5
L. Gel Permeation Chromatography (GPC).....	6
M. High Performance Liquid Chromatography (HPLC)...	6
N. Gas Chromatography (GC).....	6
O. Nuclear Magnetic Resonance (NMR).....	7
III. SUMMARY.....	8

TABLES AND CHARTS

	<u>PAGE</u>
Comparative Resin Data.....	9
91 LD Test Results and Statistical Summary.....	10
USP 39A Test Results and Statistical Summary.....	12
Typical DSC Curve.....	14
Typical RDS Curve and Data.....	16
Typical TGA Curve.....	23
GPC Calibration Plot.....	27
Typical GPC Curves.....	28
Typical HPLC Curves.....	30
Typical Gas Chromatograph Set-Up.....	34
Typical Gas Chromatograph Curves.....	35
Typical NMR Curves.....	37

RESIN TESTING

COMMENTS AND OBSERVATIONS

NAS8-36298

I. SAMPLING PLAN

The resins utilized for this contract include both 91LD - a proprietary phenol-formaldehyde resin for carbon/phenolic applications, and USP 39A - a proprietary phenylaldehyde resin for carbon/carbon applications. Both resins are received in 50-gallon drums and a sample was taken from each drum utilized on this contract. Since specification development was part of the contract, data on solids content, specific gravity, viscosity, gel time, pH and Chang's index were obtained at the time of receipt of the resin, while all other testing was performed on samples taken just prior to use. For 91LD, Lot #5, sample #1 was initially taken and tested, but it was used inadvertently for other production. Another manufacturer's lot designated #5-A was sampled and subsequently used on this contract for all Lot #5 carbon/phenolic prepgs. The resin test data for both Lot #5-1 and #5-A have been included in all resin averages and statistical summaries. Resin samples were maintained in sealed plastic containers at 4°C (40°F) until the testing was completed.

Each raw phenolic resin was mixed with USP 28 filler for each NASA production lot, so that the resin mix used in production was a blend of all drums of resin and bags of carbon black required for that particular lot, numbered 1 through 5. No special testing was conducted on the filled resin mix. Comparative resin data is given on page #9 and specific data by sample and lot on pages #10 through #13.

II. TEST METHODS AND OBSERVATIONS

A. Resin Solids

Resin solids content was determined on the resin as received, in triplicate tests, by solvent evaporation from about 1½ gms. of liquid resin in a 135°C (275°F) oven for a duration of 60 minutes. Nominally, 91LD is considered a 70% solids resin while USP 39A is a nominal 80% solids resin, and these solids levels were valid for the resin used on this contract.

B. Specific Gravity

A Hubbard pycnometer was used to determine the specific gravity at 25°C (77°F). The volume of the pycnometer was calibrated by using the weight of distilled water required to fill the pycnometer. The specific gravities of all resins used for this project are typical and in line with their respective solids contents.

C. Brookfield Viscosity

The viscosity of the resins was determined using a rotating spindle viscometer at 25°C (77°F). Results are the average of two readings and were usually determined using the #6 spindle and always utilizing 20 rpm rotational speed. Note that the USP 39A Brookfield viscosity at 15,000 centipoise (page #12) is a magnitude of ten-fold over the 91LD Brookfield viscosity at 1,200 centipoise (page #10).

D. Gel Time

Gel time was determined in a sand-filled fluidized bed equivalent to an oil bath at 170°C (338°F), recording the elapsed time from

the start of the sample heating until approximately 2 gms. of resin in a test tube gelled sufficiently to move the test tube with the wire stirrer. Note that the USP 39A has a slightly longer gel time than 91LD (page #9).

E. Atomic Absorption

The ash from a 600°C (1,112°F) pyrolysis for 16-20 hours was digested with hydrochloric acid and compared for light absorption with accurately prepared alkaline metal standards at a concentration of 0.5 ppm. It should be noted that the usual USP 39A shows a sodium level higher than that of 91LD (pages #10 and #12). This is normal and is characteristic of the starting materials for USP 39A which result in an outstanding carbon/carbon resin. The significantly higher sodium levels in USP 39A for Lot #4 (page #12) can be traced through to the prepreg and are exhibited as higher levels of sodium in both of the carbon/carbon preprints, FM 5064 (D-09315 and D-09316) and FM 5839 (D-09317) which utilized the Lot #4 resin (see uncured prepreg testing section).

F. Differential Scanning Calorimetry (DSC)

The sampled resin was tested over the range from ambient to 350°C (662°F), plotting the temperature versus heat flow (enthalphy). This technique detects the exothermic reaction which occurs when the resin gels and indicates that the peak exotherms for USP 39A resin are at a slightly higher temperature with a narrower range, than for 91LD. This relationship is also carried through to the prepreg. Typical examples of DSC charts for both resins are included on pages #14 and #15. Individual sample DSC curves are included in each of the appropriate prepreg lot fingerprints.

G. Phenol Content

Gas chromatography was the technique used to determine the free phenol content by comparison with standard solutions of phenol in isopropyl alcohol, the most prevalent volatile component of the raw resin. The data show that USP 39A contains almost 15% more free phenol than 91LD resin, which may contribute to the longer gel time for USP 39A.

H. Rheometric Dynamic Spectrometry (RDS)

The minimum resin viscosity and the temperature at which the minimum viscosity occurred was obtained by spreading liquid resin samples between parallel plates and monitoring the torsional strain between the plates as a function of temperature, giving an indication of the dynamic resin viscosity. It should be noted that the minimum viscosity of both resins occurred at 75-80°C (167-176°F) lower than their respective DSC peak exotherm temperatures. No particular significance can be placed on the lot to lot variations of the minimum viscosity of either resin system, but the viscosity of 91LD resin Lot #5-1 and #5-A are significantly lower at 60 and 40 centipoise than previous material. Typical examples of RDS plots and the corresponding data printouts for each resin system are given on pages #16 through #22 (Note: plotted in poise, not centipoise). The graphs and data for each sample are included in each of the appropriate prepreg lot fingerprints.

I. pH

The pH of the raw resin was measured, as received, using a commercial pH meter. No significant differences could be observed between the two resins utilizing this test method.

J. Chang's Index

An arbitrary measure of the relative degree of advancement or cure was made by titrating a 4% solids resin solution in acetone with distilled water. This measurement is called Chang's Index and the values reported are in milliliters of distilled water required to reach a cloudy end-point. Both resin systems showed the expected values while a more advanced resin system, or one which is more completely cured, would exhibit a Chang's index number as low as 12-15 ml. of water to reach the same end-point.

K. Thermogravimetric Analysis (TGA)

The graphical representation of weight loss in air versus temperature up to 1,000°C (1,832°F) was done on two different equipment set-ups. Lots #1, #2 and #3 of both resin systems and Lot #4 of USP 39A were determined using a Beckman OMNITHERM system. These TGA curves for USP 39A produced a "three-step" profile, while those for 91LD produced a "two-step" profile. The inflection point ranges are given below:

TGA Inflection Points, °C

	<u>First</u>	<u>Second</u>	<u>Third</u>
91LD	110-130	----	615-640
USP 39A	110-130	325-340	600-630

To quantify the lot and sample variations, an arbitrary point at 500°C on each curve was selected for comparisons. The value for the percentage of weight loss at 500°C (932°F) has been included in the data tables and shows relatively constant values between the two resin systems. Lots #4 and #5 of 91LD and Lot #5 of USP 39A

were run at U.S. Polymeric using a Perkin-Elmer TGS-2 thermo-analyser and a system IV controller with a feedback loop and have been omitted from the statistical averages due to the non-uniformity of the test equipment and the resulting lower percentage of weight loss at 500°C (932°F). A typical example for both resins showing the differences between the test equipment and the differences between the profiles are presented on pages #23 through #26. The TGA curves for individual samples are included in each of the appropriate prepreg lot fingerprints.

L. Gel Permeation Chromatography (GPC)

For separation of the resins into moleweight (size components), GPC was utilized. This technique primarily separates the larger molecules utilizing tetrahydrofuran (THF) as a solvent and estimates of the molecular weight (M_w) are based on standardized curves under identical test conditions. Typical printouts for both resin types are shown on pages #28 and #29. Individual sample GPC printouts as well as a GPC calibration plot are included in each of the appropriate prepreg lot fingerprints.

M. High Performance Liquid Chromatography (HPLC)

As a companion determination to GPC, HPLC separates chemically different components rather than molecular weight groups. Typical curves for both resin systems are included on pages #30 through #33. Individual HPLC results are included in each of the appropriate prepreg lot fingerprints.

N. Gas Chromatography (GC)

The resin samples were solvated in THF and injected into a Perkin-Elmer chromatograph to determine the volatile solvents in the resin. An

interpretation sheet for known standard solvents is included on page #34, and typical printouts for 91LD and USP39A are included on pages #35 and #36. Typical GC results indicate the following retention times and percentage areas:

	<u>91LD</u>	
	<u>Retention Time (Min)</u>	<u>Area Percent</u>
Isopropyl Alcohol	1.65 - 1.85	7.0 - 8.5
THF (Added)	3.0 - 3.3	83 - 89
Phenol (Free)	21.9 - 22.5	4 - 7

	<u>USP 39A</u>	
	<u>Retention Time (Min)</u>	<u>Area Percentage</u>
Isopropyl Alcohol	1.65 - 1.80	6.0 - 7.5
THF (Added)	2.9 - 3.3	71 - 85
Phenol (Free)	21.8 - 22.1	7.8 - 18.0

The variations in the amount of free phenol in USP 39A were more evident in this set of GC data run in December 1986 than in the phenol content test run in April 1987 by a calibrated GC procedure. Any free formaldehyde present would react with phenol due to the high temperatures involved and be reduced below the levels of detectability by this method. Individual GC printouts are included in each of the appropriate prepreg lot fingerprints.

O. Nuclear Magnetic Resonance (NMR)

Resin samples were submitted for NMR, a technique used to indicate complexity of molecular structures and special functions of protons (hydrogen atoms). All samples of 91LD resin showed a characteristic

peak at about 340 Hz (page #37), while USP 39A samples for Lots #1 through #3 are characteristically flat at that frequency (page #38). Sample #4-1 of USP 39A show a slight peak developing at 360 Hz (page #39), while Sample #5-1 (page #40) looks more like 91LD than USP 39A with the appearance of the peak at 350 Hz. It is possible that cross-contamination between resin types may have occurred either in sampling or while testing. The NMR graphs for each sample are included in the appropriate preprep lot fingerprint.

III. SUMMARY

Since both resins are basically phenolic resins, some of the test such as pH, Chang's Index and GPC are limited in their ability to distinguish between the subtle differences which make either resin suitable for its intended application. The most notable difference is in the profile of the NMR curve in the 340 Hz area and the two or three-step profile of the TGA curve. The test which best demonstrates the traceability of a particular lot of resin is the high sodium level of Lot #4 of USP 39A which shows up in both FM 5064J and FM 5839 prepreps.

Since the drums of resin which were sampled were combined to make one uniform mix for each lot, only the average lot value is useful for traceability. Generally, all other lot to lot variations are indistinguishable in the final preprep or cannot be directly tested in the preprep form. The resin solids level is adjusted after mixing with carbon black filler to control the specified resin pick-up; but the gel times of both resins maintain the same relationship, even though the amount of staging accomplished during processing is different (see uncured preprep testing section, item IIF).

COMPARATIVE RESIN DATA

NAS8-36298

91 LD RESIN FOR CARBON/PHENOLIC PREPREGS

GRAND TOTAL	RESIN SPECIFIC BROOKFIELD GEL				ATOMIC ABSORPTION					
	SOLIDS %	GRAVITY units	VISCOSITY cps.	TIME secs.	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm
AVERAGE	71.1	1.136	1,231	209	8	0	4	2	0	16
STD DEV	0.4	0.004	216	13	4	0	3	3	0	6
MINIMUM	70.7	1.128	895	186	3.5	0	0	0	0	6.5
MAXIMUM	71.7	1.141	1,500	230	14	1	10	10	1	24

USP 39A RESIN FOR CARBON/CARBON PREPREGS

GRAND TOTAL	RESIN SPECIFIC BROOKFIELD GEL				ATOMIC ABSORPTION					
	SOLIDS %	GRAVITY units	VISCOSITY cps.	TIME secs.	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm
AVERAGE	80.2	1.185	15,244	242	40.1	1.4	7.5	2.5	0.1	51.6
STD DEV	2.0	0.012	2,789	18	34.7	1.1	4.1	0.9	0.4	40.2
MINIMUM	78.2	1.167	10,000	210	12.0	0.3	2.0	1.3	0.0	19.0
MAXIMUM	83.2	1.203	18,750	262	100.0	3.0	14.5	4.0	1.0	121.0

91 LD RESIN FOR CARBON/PHENOLIC PREPREGS

GRAND TOTAL	DSC	PHENOL	R.D.S. DATA	pH	TGA		GPC	
	EXOTHERM °C	CONTENT %	MIN. VISCOSITY cps. temp °C		INDEX mls.	WT LOSS %	MOLECULAR WEIGHT	units
AVERAGE	183	11.59	207	107	8.4	24.5	39.7	1,771
STD DEV	5	0.65	93	4	0.1	0.5	1.1	109
MINIMUM	171.5	9.94	43	99	8.2	23.6	38.2	1,598
MAXIMUM	191	12.39	356	115	8.55	25.2	41.4	1,964

(LOTS 1-3 ONLY)

USP 39A RESIN FOR CARBON/CARBON PREPREGS

GRAND TOTAL	DSC	PHENOL	R.D.S. DATA	pH	TGA		GPC	
	EXOTHERM °C	CONTENT %	MIN. VISCOSITY cps. temp °C		INDEX mls.	WT LOSS %	MOLECULAR WEIGHT	units
AVERAGE	188	13.25	189	111	8.3	23.8	40.0	1,579
STD DEV	2	0.79	57	5	0.1	0.8	2.0	239
MINIMUM	185	11.83	124	105	8.18	22.2	37.9	1,231
MAXIMUM	190	14.20	290	119	8.5	24.9	42.8	1,932

(LOTS 1-4 ONLY)

91 LD RESIN TEST DATA
AVERAGE TEST RESULTS

Page #10

NAS8-36298

SAMPLE NUMBER	RESIN SOLIDS	SPECIFIC GRAVITY	BROOKFIELD VISCOSITY	GEL TIME	ATOMIC ABSORPTION					
					Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm
METHOD	PTM-7C	PTM-29C	PTM-14C	PTM-47B	-----CTM 53B-----					
1-1	70.8	1.137	1,000	204	8	1	10	1	0	20
1-2	70.8	1.136	1,000	200	9	1	9	1	0	20
1-3	70.9	1.137	1,000	202	10	1	8	1	0	20
2-1	71.2	1.141	1,250	210	4	0	3	1	0	8
2-2	70.9	1.140	1,250	218	4	0	2	1	1	8
2-3	71.1	1.139	1,500	214	8	0	2	1	0	11
3-1	71.7	1.129	1,250	220	8	0	5	1	1	15
3-2	71.3	1.131	1,375	218	14	0	5	1	1	21
3-3	71.6	1.128	1,250	213	14	0	5	1	1	21
4-1	70.9	1.140	895	190	13	1	2	8	0	24
5-1	71.7	1.139	1,500	230	4	0	0	10	0	14
5-A	70.7	1.138	1,500	186	3.5	0.5	2.5	0.0	0.0	6.5

91 LD GRAND TOTAL	RESIN SOLIDS	SPECIFIC GRAVITY	BROOKFIELD VISCOSITY	GEL TIME	ATOMIC ABSORPTION						
					%	units	cps.	secs.	Na ppm	K ppm	Ca ppm
AVERAGE	71.1	1.136	1,231	209	8	0	4	2	0	16	
STD DEV	0.4	0.004	216	13	4	0	3	3	0	6	
MINIMUM	70.7	1.128	895	186	3.5	0	0	0	0	0	6.5
MAXIMUM	71.7	1.141	1,500	230	14	1	10	10	1	24	

(NOTE: LOT #5-1 WAS TESTED, BUT NOT USED IN PRODUCTION.)

91 LD RESIN
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	RESIN SOLIDS	SPECIFIC GRAVITY	BROOKFIELD VISCOSITY	GEL TIME	ATOMIC ABSORPTION						
					%	units	cps.	secs.	Na ppm	K ppm	Ca ppm
LOT #1	70.8	1.137	1,000	202	9	1	9	1	0	20	
LOT #2	71.1	1.140	1,333	214	5	0	2	1	0	9	
LOT #3	71.5	1.129	1,292	217	12	0	5	1	1	19	
LOT #4	70.9	1.140	895	190	13	1	2	8	0	24	
LOT #5A	70.7	1.138	1,500	186	4	1	3	0	0	7	
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
GRAND AVG.	71.1	1.136	1,231	209	8	0	4	2	0	16	
STD DEV	0.4	0.004	216	13	4	0	3	3	0	6	
COUNT	12	12	12	12	12	12	12	12	12	12	
<u>A BASIS</u>											
FACTOR	3.747	3.747	3.747	3.747	3.747	3.747	3.747	3.747	3.747	3.747	3.747
MINIMUM	69.8	1.120	422	161	-6	-1	-7	-10	-2	-7	-7
MAXIMUM	72.5	1.153	2,039	257	23	2	16	14	2	39	

91 LD RESIN TEST DATA
AVERAGE TEST RESULTS

Page #11

NAS8-36298

SAMPLE NUMBER	DSC EXOTHERM °C	PHENOL CONTENT %	R.D.S. DATA MIN. VISCOSITY cps. temp °C	pH	CHANG'S INDEX	TGA WT LOSS at 500 °C %	GPC MOLECULAR WEIGHT units
METHOD	CTM-50A	CTM-55	---CTM-57A---	CTM-1B	CTM-5B	CTM-51	CTM-49A
1-1	187	11.05	356 99	8.4	23.6	41.4	1,770
1-2	182	11.96	194 104	8.3	23.8	40.5	1,816
1-3	183	11.93	153 108	8.3	23.8	40.8	1,658
2-1	183	9.94	278 107	8.5	24.2	39.5	1,718
2-2	191	10.94	249 111	8.3	24.8	40.1	1,801
2-3	183	11.81	239 113	8.4	25.2	39.4	1,598
3-1	178	12.39	179 107	8.5	24.8	38.7	1,666
3-2	183	12.01	212 115	8.5	24.6	38.5	1,751
3-3	185	11.72	201 107	8.55	25.2	38.2	1,838
4-1	186	11.63	323 105	8.2	24.5	8.1?	1,964
5-1	188	11.84	60 109	8.3	24.8	8.4?	1,902
5-A	171.5	11.84	43 102	8.3	24.8	--	235?

91 LD GRAND TOTAL	DSC EXOTHERM °C	PHENOL CONTENT %	R.D.S. DATA MIN. VISCOSITY cps. temp °C	pH	CHANG'S INDEX	TGA WT LOSS at 500 °C %	GPC MOLECULAR WEIGHT units
AVERAGE	183	11.59	207 107	8.4	24.5	39.7	1,771
STD DEV	5	0.65	93 4	0.1	0.5	1.1	109
MINIMUM	171.5	9.94	43 99	8.2	23.6	38.2	1,598
MAXIMUM	191	12.39	356 115	8.55	25.2	41.4	1,964

(NOTE: LOT #5-1 WAS TESTED, BUT NOT USED IN PRODUCTION.) (LOTS 1-3 ONLY)

91 LD RESIN
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	DSC EXOTHERM °C	PHENOL CONTENT %	R.D.S. DATA MIN. VISCOSITY cps. temp °C	pH	CHANG'S INDEX	TGA WT LOSS at 500 °C %	GPC MOLECULAR WEIGHT units
LOT #1	184	11.65	234 104	8.3	23.7	40.9	1,748
LOT #2	186	10.90	255 110	8.4	24.7	39.7	1,706
LOT #3	182	12.04	197 110	8.5	24.9	38.5	1,752
LOT #4	186	11.63	323 105	8.2	24.5	8.1?	1,964
LOT #5A	171.5	11.84	43 102	8.3	24.8	--	235?
=====							
GRAND AVG.	183	11.59	207 107	8.4	24.5	39.7	1,771
STD DEV	5	0.65	93 4	0.1	0.5	1.1	109
COUNT	12	12	12 12	12	12	9	11
<u>A BASIS</u>							
FACTOR	3.747	3.747	3.747 3.747	3.747	3.747	4.143	3.852
MINIMUM	165	9.14	-143 90	8.0	22.5	35.1	1,351
MAXIMUM	202	14.04	557 124	8.8	26.5	44.2	2,191

(LOTS 1-3 ONLY)

USP 39A RESIN TEST DATA
AVERAGE TEST RESULTS

Page #12

NAS8-36298

SAMPLE NUMBER	RESIN SOLIDS	SPECIFIC GRAVITY	BROOKFIELD cps.	GEL secs.	ATOMIC ABSORPTION					
					Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm
METHOD	PTM-7C	PTM-29C	PTM-14C	PTM-47B	-----CTM 53B-----					
1-1	80.3	1.186	16,750	210	22.5	0.3	5.3	2.0	0.0	30.0
1-2	80.8	1.193	18,750	227	31.3	0.5	5.8	2.0	0.0	39.5
2-1	78.9	1.189	17,400	240	25.0	1.0	7.5	2.0	0.0	35.5
2-2	79.2	1.193	16,800	260	20.8	0.5	7.0	2.0	0.0	30.3
3-1	78.2	1.181	15,000	262	18.0	1.8	5.8	1.3	0.0	26.8
4-1	83.0	1.167	13,750	255	91.0	3.0	12.5	4.0	0.0	110.5
4-2	83.2	1.169	13,500	245	100.0	3.0	14.5	3.5	0.0	121.0
5-1	78.4	1.203	10,000	234	12.0	1.0	2.0	3.0	1.0	19.0

USP-39A											
GRAND TOTAL	RESIN SOLIDS	SPECIFIC GRAVITY	BROOKFIELD cps.	GEL secs.	ATOMIC ABSORPTION						
	%	units			Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm	
AVERAGE	80.2	1.185	15,244	242	40.1	1.4	7.5	2.5	0.1	51.6	
STD DEV	2.0	0.012	2,789	18	34.7	1.1	4.1	0.9	0.4	40.2	
MINIMUM	78.2	1.167	10,000	210	12.0	0.3	2.0	1.3	0.0	19.0	
MAXIMUM	83.2	1.203	18,750	262	100.0	3.0	14.5	4.0	1.0	121.0	

USP 39A RESIN
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	RESIN SOLIDS	SPECIFIC GRAVITY	BROOKFIELD cps.	GEL secs.	ATOMIC ABSORPTION					
					Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm
LOT #1	80.6	1.190	17,750	219	26.9	0.4	5.5	2.0	0.0	34.8
LOT #2	79.1	1.191	17,100	250	22.9	0.8	7.3	2.0	0.0	32.9
LOT #3	78.2	1.181	15,000	262	18.0	1.8	5.8	1.3	0.0	26.8
LOT #4	83.1	1.168	13,625	250	95.5	3.0	13.5	3.8	0.0	115.8
LOT #5	78.4	1.203	10,000	234	12.0	1.0	2.0	3.0	1.0	19.0

GRAND AVG.	80.2	1.185	15,244	242	40.1	1.4	7.5	2.5	0.1	51.6
STD DEV	2.0	0.012	2,789	18	34.7	1.1	4.1	0.9	0.4	40.2
COUNT	8	8	8	8	8	8	8	8	8	8
<u>A BASIS</u>										
FACTOR	4.354	4.354	4.354	4.354	4.354	4.354	4.354	4.354	4.354	4.354
MINIMUM	71.6	1.131	3,099	164	-111	-3	-10	-2	-1	-123
MAXIMUM	88.8	1.239	27,388	319	191	6	25	7	2	226

DRUGS, INC.
OF PORTLAND

ORIGINAL PAGE IS
OF POOR QUALITY

USP 39A RESIN TEST DATA
AVERAGE TEST RESULTS

Page #13

NAS8-36298

SAMPLE NUMBER	DSC EXOTHERM °C	PHENOL CONTENT %	R.D.S. DATA MIN. VISCOSITY cps. temp °C	pH	CHANG'S INDEX	TGA WT LOSS at 500 °C	GPC MOLECULAR WEIGHT units
METHOD	CTM-50A	CTM-55	---CTM-57A--	CTM-1B	CTM-5B	CTM-51	CTM-49A
1-1	187	13.83	229 115	8.3	23.4	39.1	1,231
1-2	187	14.00	290 119	8.4	23.8	37.9	1,291
2-1	190	13.12	172 114	8.4	23.6	39.4	1,800
2-2	189	13.48	124 114	8.5	23.8	38.2	1,631
3-1	185	11.83	175 111	8.2	22.2	39.9	1,932
4-1	186	12.69	148 106	8.18	24.9	42.8	1,679
4-2	188	12.88	143 106	8.2	24.6	42.5	1,577
5-1	189	14.20	235 105	8.3	24.1	16.3?	1,489
<hr/>							
USP-39A	DSC EXOTHERM °C	PHENOL CONTENT %	R.D.S. DATA MIN. VISCOSITY cps. temp °C	pH	CHANG'S INDEX	TGA WT LOSS at 500 °C	GPC MOLECULAR WEIGHT units
GRAND TOTAL	CTM-50A	CTM-55	---CTM-57A--	CTM-1B	CTM-5B	CTM-51	CTM-49A
AVERAGE	188	13.25	189 111	8.3	23.8	40.0	1,579
STD DEV	2	0.79	57 5	0.1	0.8	2.0	239
MINIMUM	185	11.83	124 105	8.18	22.2	37.9	1,231
MAXIMUM	190	14.20	290 119	8.5	24.9	42.8	1,932

(LOTS 1-4 ONLY)

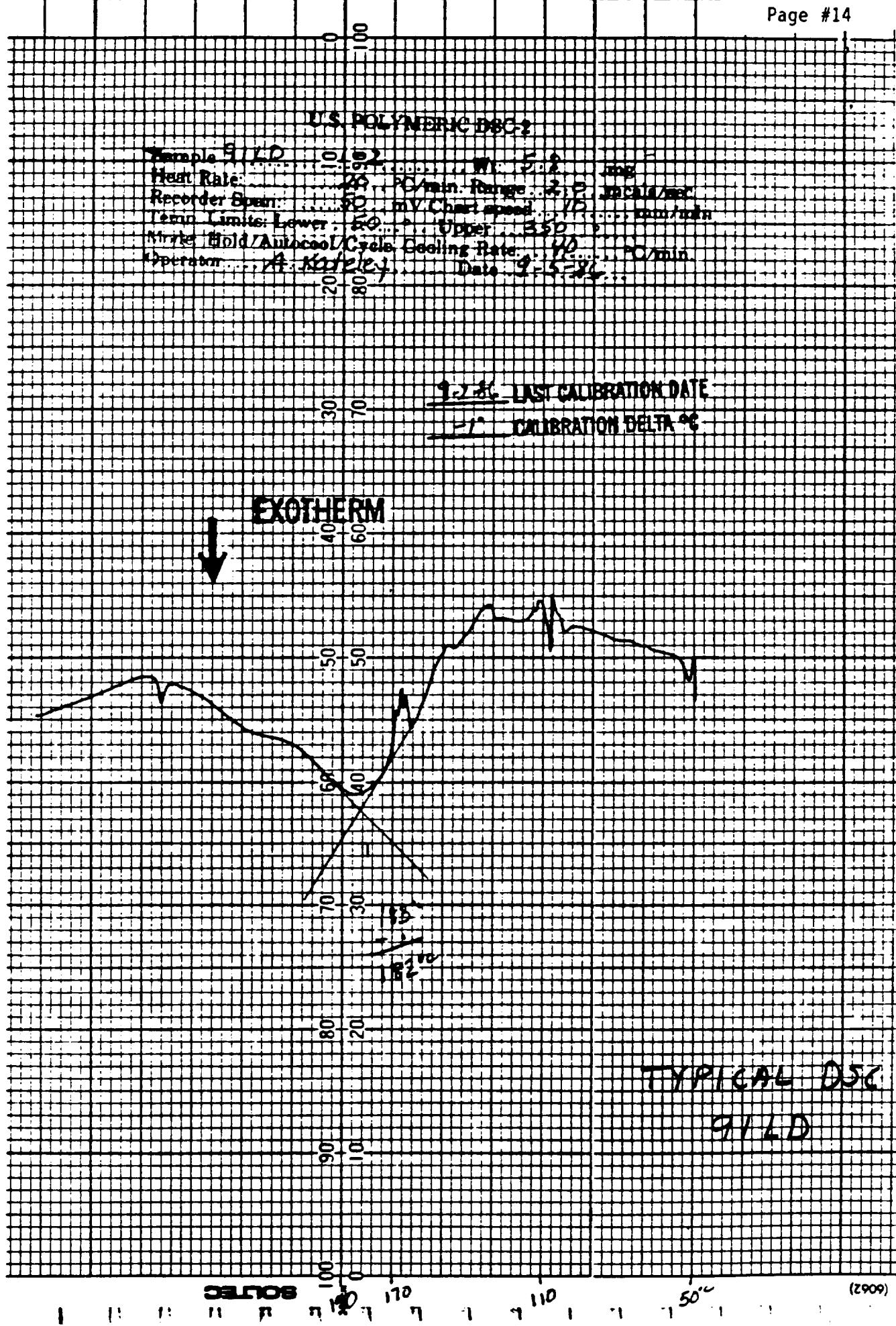
USP 39A RESIN
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	DSC EXOTHERM °C	PHENOL CONTENT %	R.D.S. DATA MIN. VISCOSITY cps. temp °C	pH	CHANG'S INDEX	TGA WT LOSS at 500 °C	GPC MOLECULAR WEIGHT units
LOT #1	187	13.91	259 117	8.4	23.6	38.5	1,261
LOT #2	190	13.30	148 114	8.5	23.7	38.8	1,716
LOT #3	185	11.83	175 111	8.2	22.2	39.9	1,932
LOT #4	187	12.79	145 106	8.2	24.8	42.7	1,628
LOT #5	189	14.20	235 105	8.3	24.1	16.3?	1,489
<hr/>							
GRAND AVG.	188	13.25	189 111	8.3	23.8	40.0	1,579
STD DEV	2	0.79	57 5	0.1	0.8	2.0	239
COUNT	8	8	8	8	8	8	8
<u>A BASIS</u>							
FACTOR	4.354	4.354	4.354	4.354	4.354	4.642	4.354
MINIMUM	180	9.83	-57	89	7.8	20.2	30.9
MAXIMUM	195	16.68	436	134	8.8	27.4	540

(LOTS 1-4 ONLY)

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OF POOR QUALITY



PART NO. 990088

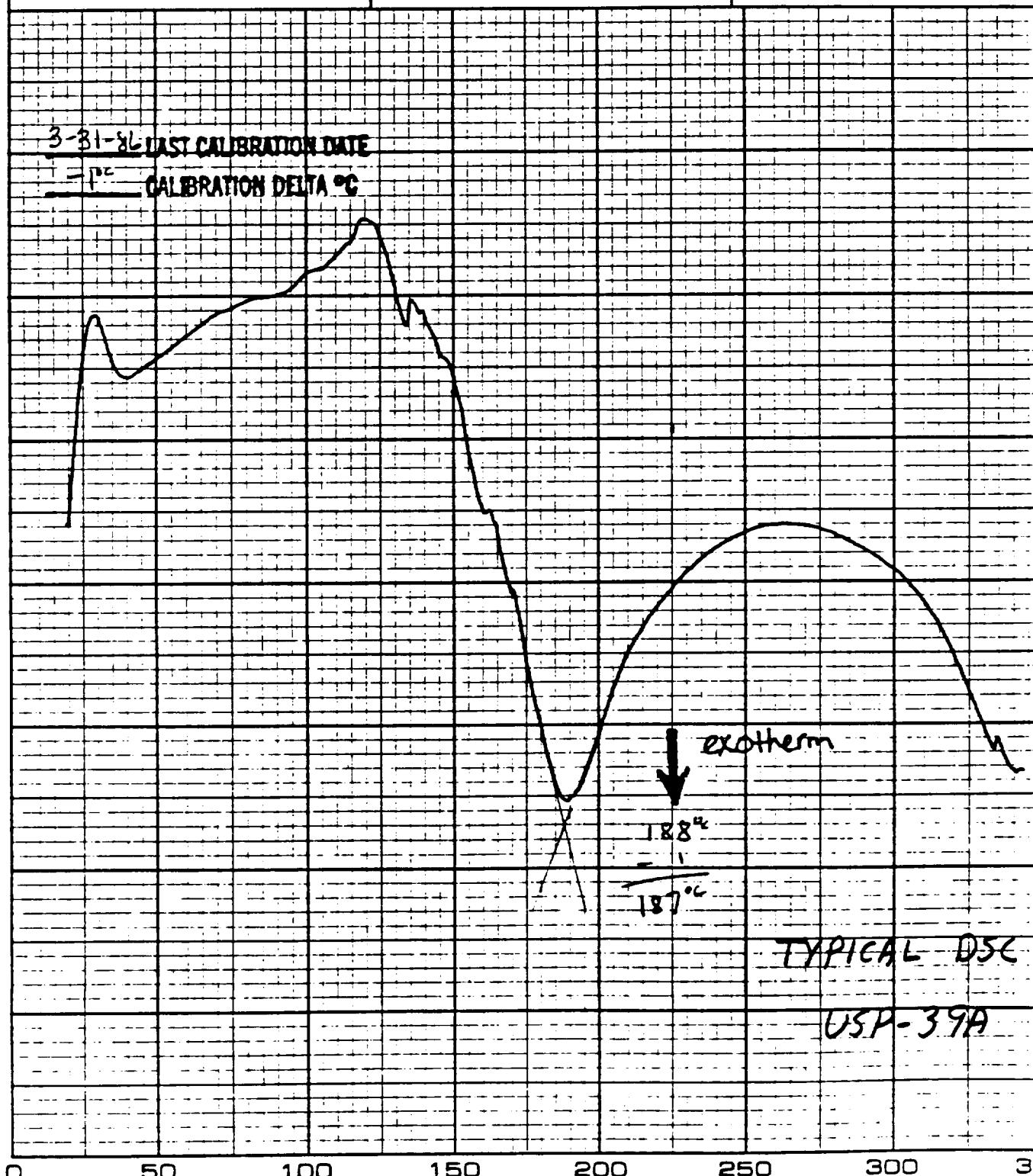
Page #15

RUN NO _____ DATE <u>4/3/86</u>	T-AXIS	DTA-DSC
OPERATOR <u>JJ</u>	SCALE, °C/in <u>50</u>	SCALE, °C/in <u>1.0 / 5</u>
SAMPLE: <u>USP-39A #1-2</u>	PROG. RATE, °C/min <u>20</u>	(mcal/sec)/in
ATM <u>H₂</u> @ 1 atm	HEAT <u>Cool</u> ISO	WEIGHT, mg <u>3.4</u>
FLOW RATE <u>40 ml/min</u>	SHIFT, in <u>0</u>	REFERENCE <u>1 AL CUP & SETC</u>
	- 1° AC° -	

DuPont Instruments



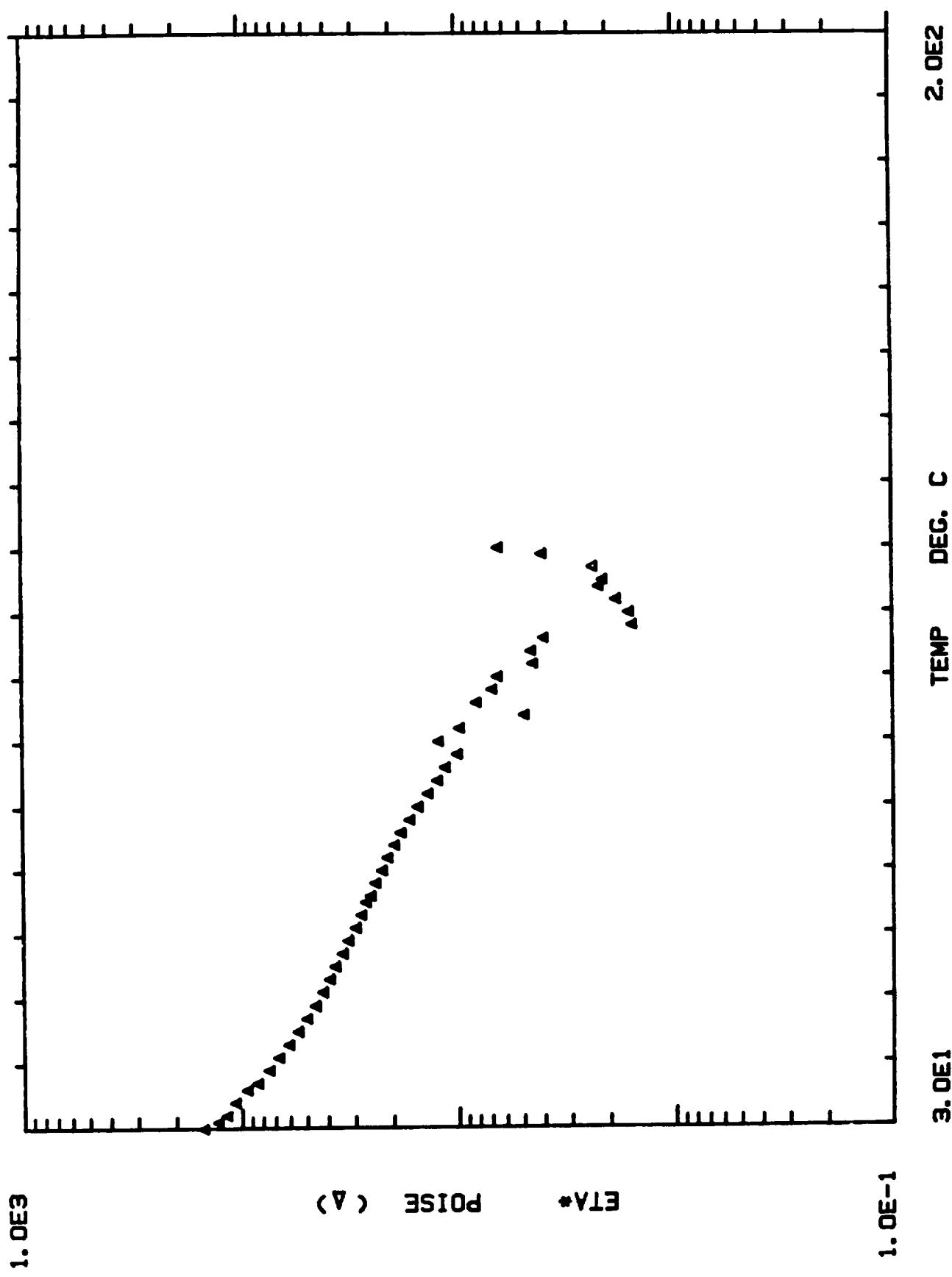
MEASURED VARIABLE



0 50 100 150 200 250 300 350

TEMPERATURE, °C (CHRO)

NASA FINGERPRINT VISCOSITY PROFILE 911D RESIN NASA LOT1-3



Experiment No. : 11 Sample No. : 1

Title:

NASA FINGERPRINT VISCOSITY PROFILE 91LD RESIN NASA LOT1-3

Operator : CP

Date and Time : Tuesday, August 19, 1986 - 12:08:02

Operating Mode : DYNAMIC

Sweep Type : CURE

Geometry : DISK & PLATE

RADIUS : 25.00

GAP : 0.50

Notes :

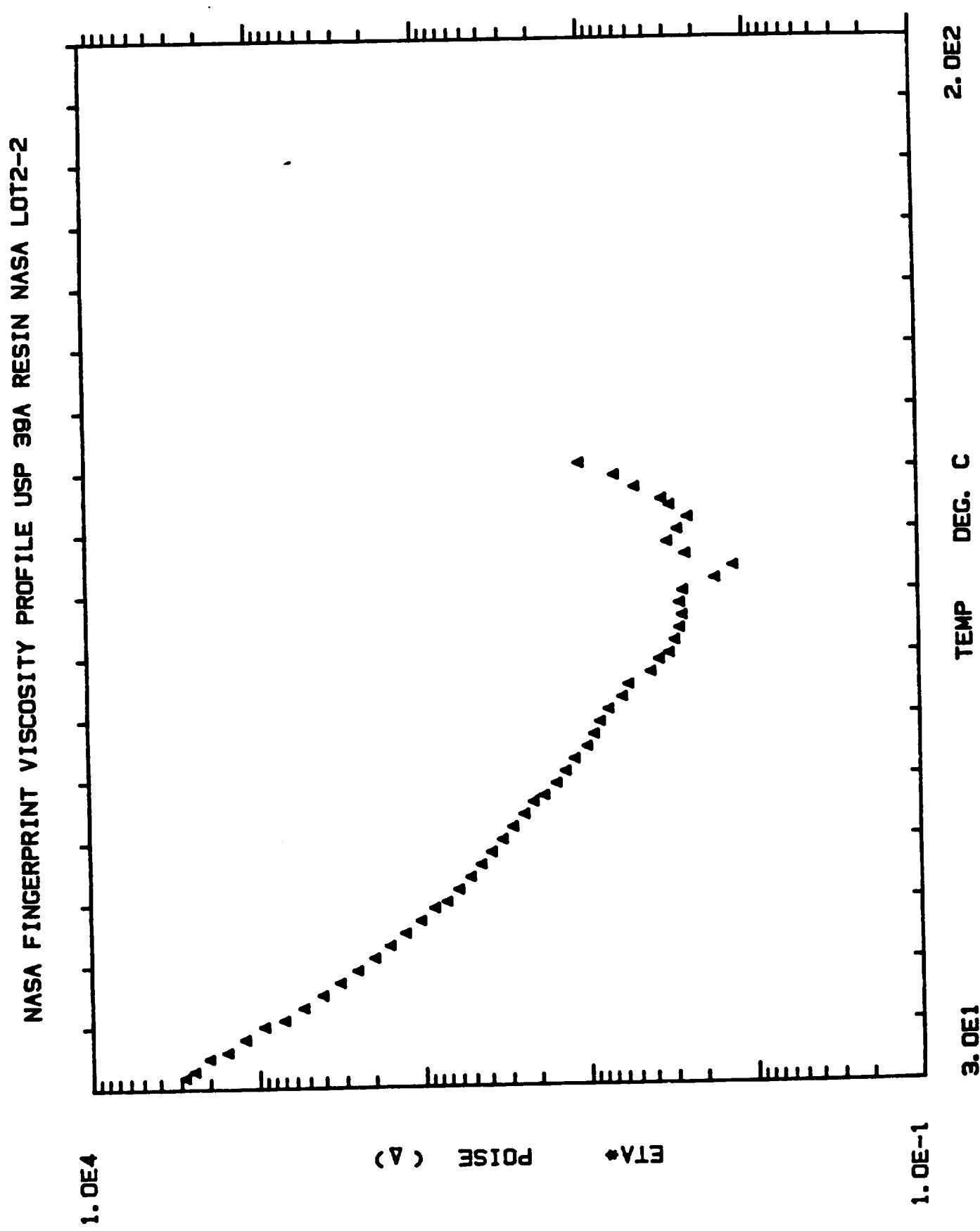
STRAIN =50%

FREQUENCY =10RAD/SEC

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OF POOR QUALITY

NO.	ETA*	ETA'	ETA"	TORQUE	TIME	TEMP
	POISE	POISE	POISE	GRAMS-CM	MIN.	DEG. C
1	1.471e+002	1.349e+002	3.847e+001	1.847e+001	2.000e-001	3.000e+001
2	1.259e+002	1.172e+002	4.595e+001	1.581e+001	1.000e+000	3.100e+001
3	1.148e+002	1.062e+002	4.348e+001	1.440e+001	2.000e+000	3.200e+001
4	1.046e+002	9.552e+001	4.271e+001	1.313e+001	3.000e+000	3.400e+001
5	9.263e+001	8.327e+001	4.057e+001	1.163e+001	4.000e+000	3.600e+001
6	8.269e+001	7.285e+001	3.912e+001	1.037e+001	5.000e+000	3.700e+001
7	7.314e+001	6.306e+001	3.704e+001	9.180e+000	6.000e+000	3.900e+001
8	6.589e+001	5.563e+001	3.531e+001	8.267e+000	7.000e+000	4.100e+001
9	5.923e+001	4.858e+001	3.389e+001	7.434e+000	8.000e+000	4.300e+001
10	5.370e+001	4.271e+001	3.255e+001	6.746e+000	9.000e+000	4.500e+001
11	4.883e+001	3.791e+001	3.079e+001	6.126e+000	1.000e+001	4.700e+001
12	4.458e+001	3.336e+001	2.957e+001	5.596e+000	1.100e+001	4.900e+001
13	4.110e+001	2.968e+001	2.843e+001	5.157e+000	1.200e+001	5.100e+001
14	3.834e+001	2.700e+001	2.722e+001	4.813e+000	1.300e+001	5.300e+001
15	3.601e+001	2.475e+001	2.616e+001	4.518e+000	1.400e+001	5.500e+001
16	3.331e+001	2.269e+001	2.438e+001	4.181e+000	1.500e+001	5.700e+001
17	3.137e+001	2.154e+001	2.281e+001	3.940e+000	1.600e+001	5.900e+001
18	2.890e+001	2.021e+001	2.066e+001	3.628e+000	1.700e+001	6.100e+001
19	2.730e+001	1.954e+001	1.906e+001	3.428e+000	1.800e+001	6.300e+001
20	2.601e+001	1.895e+001	1.780e+001	3.264e+000	1.900e+001	6.500e+001
21	2.474e+001	1.860e+001	1.632e+001	3.108e+000	2.000e+001	6.600e+001
22	2.352e+001	1.817e+001	1.494e+001	2.954e+000	2.100e+001	6.800e+001
23	2.191e+001	1.767e+001	1.296e+001	2.752e+000	2.200e+001	7.000e+001
24	2.068e+001	1.723e+001	1.143e+001	2.595e+000	2.300e+001	7.200e+001
25	1.923e+001	1.646e+001	9.937e+000	2.416e+000	2.400e+001	7.400e+001
26	1.798e+001	1.593e+001	8.339e+000	2.257e+000	2.500e+001	7.600e+001
27	1.633e+001	1.472e+001	7.077e+000	2.051e+000	2.600e+001	7.800e+001
28	1.497e+001	1.371e+001	6.005e+000	1.881e+000	2.700e+001	8.000e+001
29	1.348e+001	1.247e+001	5.062e+000	1.690e+000	2.800e+001	8.200e+001
30	1.216e+001	1.133e+001	4.436e+000	1.528e+000	2.900e+001	8.400e+001
31	1.119e+001	1.048e+001	3.941e+000	1.406e+000	3.000e+001	8.600e+001
32	9.831e+000	9.239e+000	3.361e+000	1.235e+000	3.100e+001	8.800e+001
33	1.202e+001	1.122e+001	4.301e+000	1.508e+000	3.200e+001	9.000e+001
34	9.617e+000	9.156e+000	2.937e+000	1.208e+000	3.300e+001	9.200e+001
35	4.823e+000	4.639e+000	1.319e+000	6.062e-001	3.400e+001	9.400e+001
36	8.066e+000	7.930e+000	1.477e+000	1.013e+000	3.500e+001	9.600e+001
37	6.802e+000	6.696e+000	1.198e+000	8.550e-001	3.600e+001	9.800e+001
38	5.423e+000	6.344e+000	9.988e-001	8.066e-001	3.700e+001	1.000e+002
39	4.400e+000	4.267e+000	1.076e+000	5.529e-001	3.800e+001	1.020e+002
40	4.481e+000	4.398e+000	8.549e-001	5.624e-001	3.900e+001	1.040e+002
41	3.917e+000	3.869e+000	6.140e-001	4.922e-001	4.000e+001	1.060e+002
42	1.527e+000	1.326e+000	7.579e-001	1.917e-001	4.100e+001	1.080e+002
43	1.560e+000	1.399e+000	7.330e-001	1.985e-001	4.200e+001	1.100e+002
44	1.211e+000	1.505e+000	1.007e+000	2.273e-001	4.300e+001	1.120e+002
45	2.179e+000	2.083e+000	6.388e-001	2.738e-001	4.400e+001	1.140e+002
46	2.082e+000	1.834e+000	9.966e-001	2.623e-001	4.500e+001	1.150e+002
47	2.322e+000	2.192e+000	7.836e-001	2.924e-001	4.600e+001	1.170e+002
48	3.996e+000	3.866e+000	1.009e+000	5.026e-001	4.700e+001	1.190e+002
49	6.370e+000	5.971e+000	2.219e+000	8.005e-001	4.800e+001	1.200e+002

GRADUATION



Experiment No. : 3 Sample No. : 1

Title:
NAEA FINGERPRINT VISCOSITY PROFILE UEP 39A RESIN NAEA LOT2-2

Operator : CP

Date and Time : Friday, August 15, 1986 - 13:50:53

Operating Mode : DYNAMIC

Sheep Type : CURE

Geometry : DISK & PLATE
RADIUS : 25.00
GAP : 0.50

Notes :
STRAIN =50%
FREQUENCY =10 RAD/SEC

ORIGINAL PAGE IS
OF POOR QUALITY

NO.	ETA*	ETA'	ETA"	TORQUE GRAMS-CM	TIME MIN.	TEMP DEG. C
	POISE	POISE	POISE			
1	2.748e+003	2.747e+003	4.963e+001	3.500e+002	2.000e+001	3.200e+001
2	2.751e+003	2.750e+003	5.589e+001	3.503e+002	1.000e+000	3.200e+001
3	2.407e+003	2.407e+003	4.550e+001	3.062e+002	2.000e+000	3.300e+001
4	1.952e+003	1.952e+003	4.134e+001	2.476e+002	3.000e+000	3.500e+001
5	1.521e+003	1.520e+003	3.489e+001	1.925e+002	4.000e+000	3.600e+001
6	1.181e+003	1.180e+003	3.659e+001	1.493e+002	5.000e+000	3.800e+001
7	9.014e+002	9.010e+002	2.717e+001	1.137e+002	6.000e+000	4.000e+001
8	6.251e+002	6.845e+002	2.800e+001	8.640e+001	7.000e+000	4.100e+001
9	5.225e+002	5.219e+002	2.522e+001	6.579e+001	8.000e+000	4.300e+001
10	4.013e+002	4.007e+002	2.174e+001	5.052e+001	9.000e+000	4.500e+001
11	3.136e+002	3.129e+002	2.112e+001	3.947e+001	1.000e+001	4.700e+001
12	2.457e+002	2.449e+002	2.013e+001	3.090e+001	1.100e+001	4.900e+001
13	1.938e+002	1.928e+002	1.994e+001	2.436e+001	1.200e+001	5.100e+001
14	1.561e+002	1.549e+002	1.938e+001	1.961e+001	1.300e+001	5.300e+001
15	1.257e+002	1.244e+002	1.839e+001	1.580e+001	1.400e+001	5.500e+001
16	1.014e+002	1.003e+002	1.543e+001	1.273e+001	1.500e+001	5.700e+001
17	8.340e+001	8.234e+001	1.320e+001	1.047e+001	1.600e+001	5.900e+001
18	7.053e+001	6.940e+001	1.145e+001	8.840e+000	1.700e+001	6.000e+001
19	5.969e+001	5.824e+001	1.001e+001	7.496e+000	1.800e+001	6.200e+001
20	5.047e+001	4.972e+001	8.644e+000	6.340e+000	1.900e+001	6.400e+001
21	4.240e+001	4.276e+001	7.440e+000	5.447e+000	2.000e+001	6.600e+001
22	3.759e+001	3.701e+001	6.560e+000	4.720e+000	2.100e+001	6.800e+001
23	3.215e+001	3.168e+001	5.477e+000	4.034e+000	2.200e+001	7.000e+001
24	2.777e+001	2.755e+001	4.723e+000	3.485e+000	2.300e+001	7.200e+001
25	2.370e+001	2.333e+001	4.172e+000	2.977e+000	2.400e+001	7.400e+001
26	2.079e+001	2.049e+001	3.492e+000	2.609e+000	2.500e+001	7.600e+001
27	1.794e+001	1.770e+001	2.927e+000	2.253e+000	2.600e+001	7.700e+001
28	1.506e+001	1.483e+001	2.647e+000	1.890e+000	2.700e+001	7.900e+001
29	1.327e+001	1.309e+001	2.197e+000	1.666e+000	2.800e+001	8.100e+001
30	1.166e+001	1.154e+001	1.650e+000	1.463e+000	2.900e+001	8.300e+001
31	9.723e+000	9.579e+000	1.742e+000	1.222e+000	3.000e+001	8.500e+001
32	8.840e+000	8.742e+000	1.311e+000	1.110e+000	3.100e+001	8.700e+001
33	8.088e+000	7.995e+000	1.222e+000	1.015e+000	3.200e+001	8.900e+001
34	7.169e+000	7.105e+000	9.554e-001	9.000e-001	3.300e+001	9.100e+001
35	6.902e+000	5.868e+000	6.306e-001	7.406e-001	3.400e+001	9.300e+001
36	5.403e+000	5.353e+000	7.365e-001	6.783e-001	3.500e+001	9.500e+001
37	3.945e+000	3.945e+000	3.298e-002	4.951e-001	3.600e+001	9.700e+001
38	3.514e+000	3.503e+000	2.691e-001	4.410e-001	3.700e+001	9.900e+001
39	3.057e+000	3.055e+000	1.028e-001	3.835e-001	3.800e+001	1.000e+002
40	2.824e+000	2.824e+000	5.250e-002	3.546e-001	3.900e+001	1.020e+002
41	2.639e+000	2.638e+000	5.008e-002	3.310e-001	4.000e+001	1.040e+002
42	2.532e+000	2.532e+000	0.000e+000	3.180e-001	4.100e+001	1.060e+002
43	2.625e+000	2.619e+000	1.781e-001	3.298e-001	4.200e+001	1.080e+002
44	2.504e+000	2.427e+000	6.148e-001	3.143e-001	4.300e+001	1.100e+002
45	1.607e+000	1.519e+000	5.247e-001	2.019e-001	4.400e+001	1.120e+002
46	1.244e+000	1.234e+000	1.583e-001	1.580e-001	4.500e+001	1.140e+002
47	2.421e+000	2.362e+000	5.321e-001	3.040e-001	4.600e+001	1.160e+002
48	3.097e+000	2.937e+000	9.815e-001	3.838e-001	4.700e+001	1.180e+002
49	2.854e+000	2.593e+000	6.906e-001	3.370e-001	4.800e+001	1.200e+002
50	2.321e+000	2.208e+000	7.159e-001	2.914e-001	4.900e+001	1.220e+002

ORIGINAL IS OF
POOR QUALITY

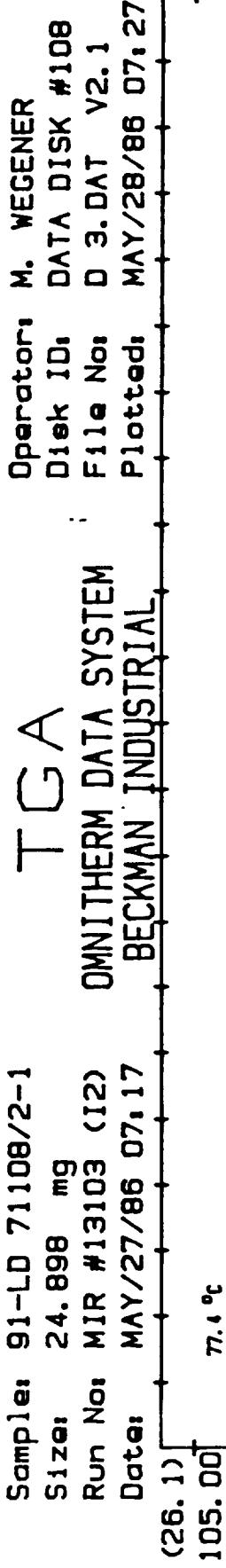
NASA FINGERPRINT VISCOSITY PROFILE USP 39A RESIN NASA LOT2-2

Page #22

NO.	ETA*	ETA'	ETA"	TORQUE	TIME	TEMP
	POISE	POISE	POISE	GRAMS-CM	MIN.	DEG. C
51	2.992e+000	2.773e+000	1.074e+000	3.755e-001	5.000e+001	1.240e+002
52	3.334e+000	3.139e+000	1.123e+000	4.188e-001	5.100e+001	1.250e+002
53	4.823e+000	4.690e+000	1.125e+000	6.053e-001	5.200e+001	1.270e+002
54	6.376e+000	6.167e+000	1.617e+000	8.006e-001	5.300e+001	1.290e+002
55	1.043e+001	9.972e+000	3.074e+000	1.309e+000	5.400e+001	1.310e+002

Sample: 91-LD 71108/2-1
Size: 24.898 mg
Run No: MIR #13103 (12)
Date: MAY/27/86 07:17

OMNITHERM DATA SYSTEM
BECKMAN INDUSTRIAL



TYPICAL
91LD
TWO- STEP TGA

* METHOD *
SAMPLE RATE= 3
START FINAL RATE TIME GAS
1 25 900 20 AIR

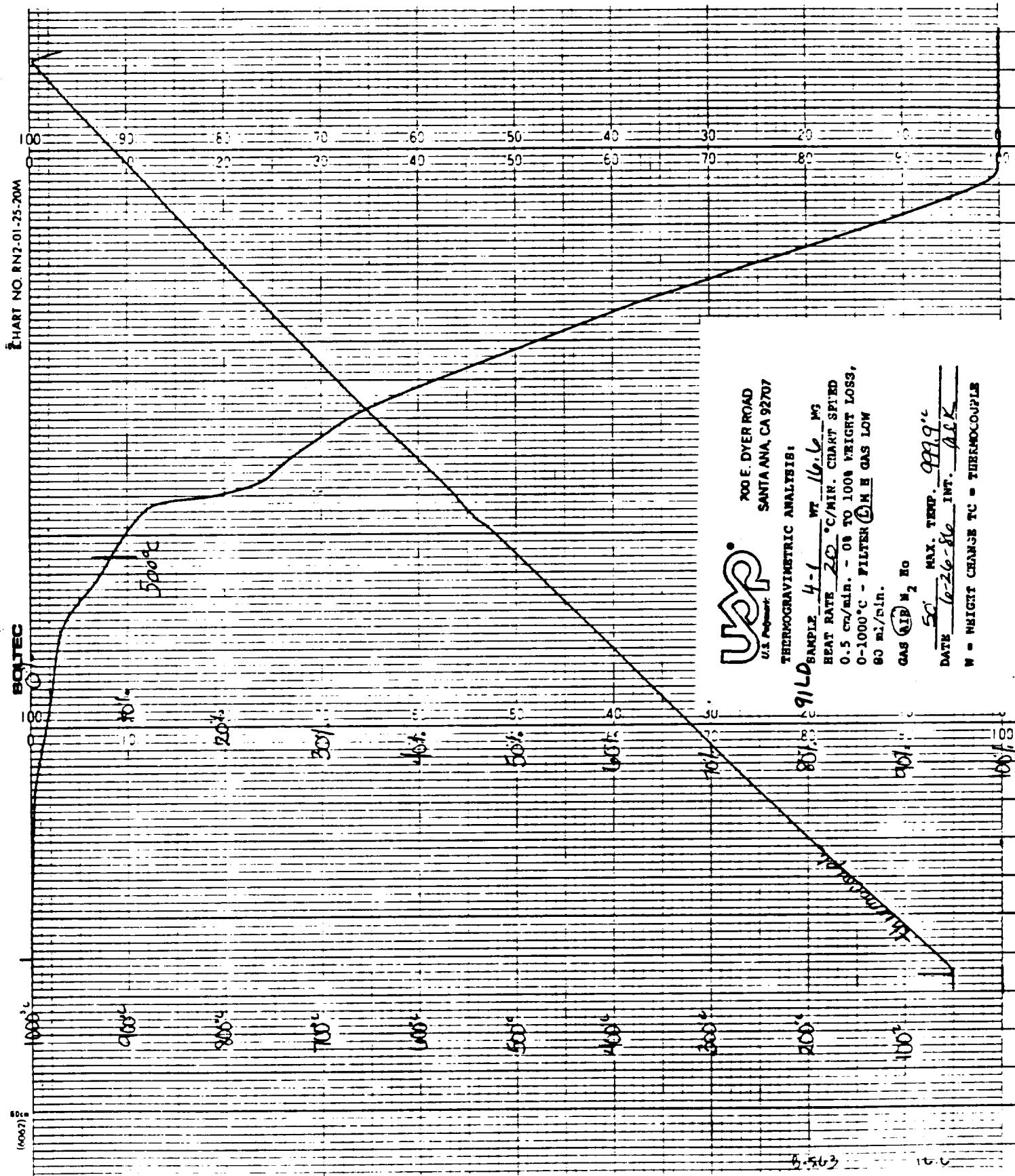
84.058 ±
623.8 °C

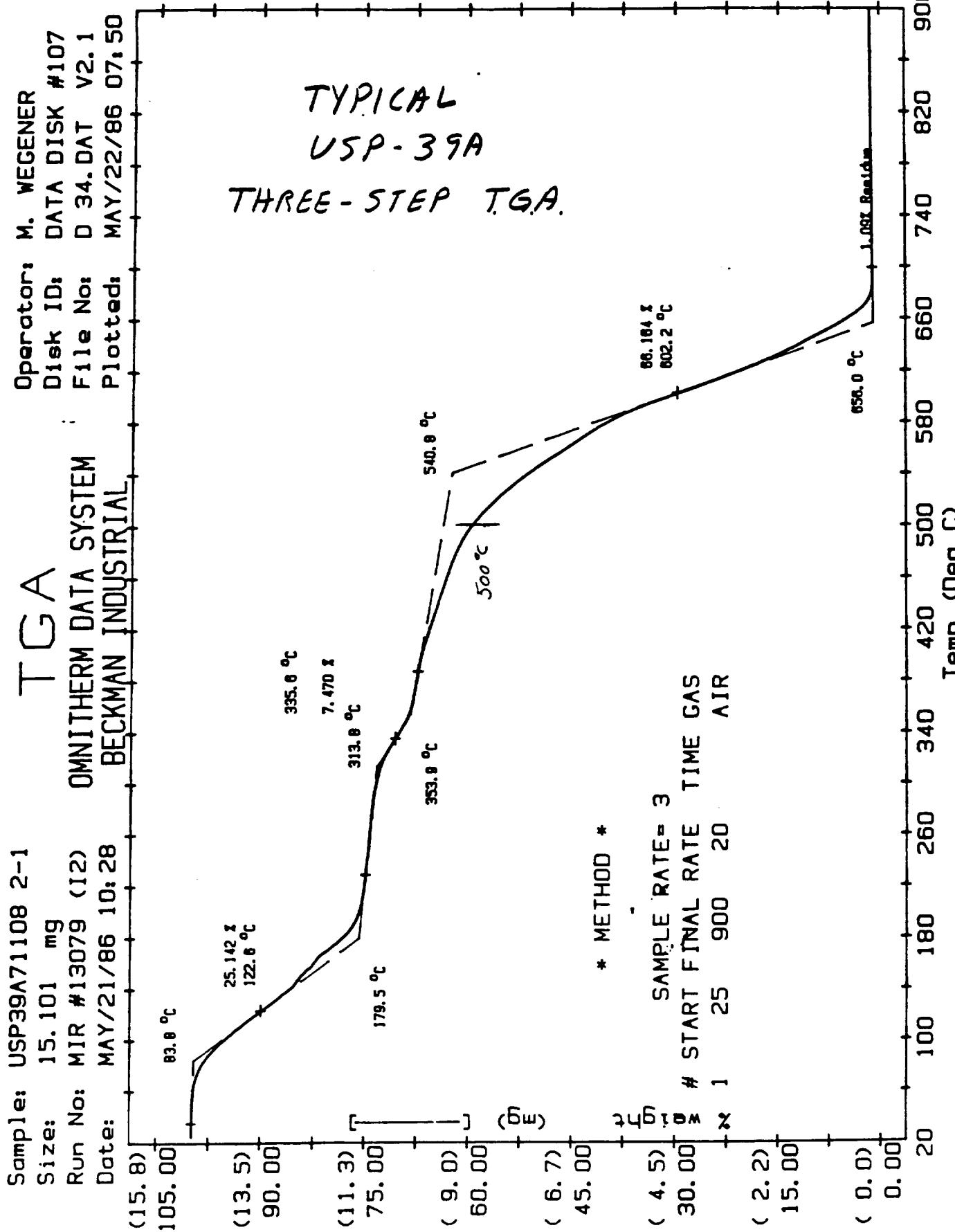
700.4 °C

Temp (Deg C)

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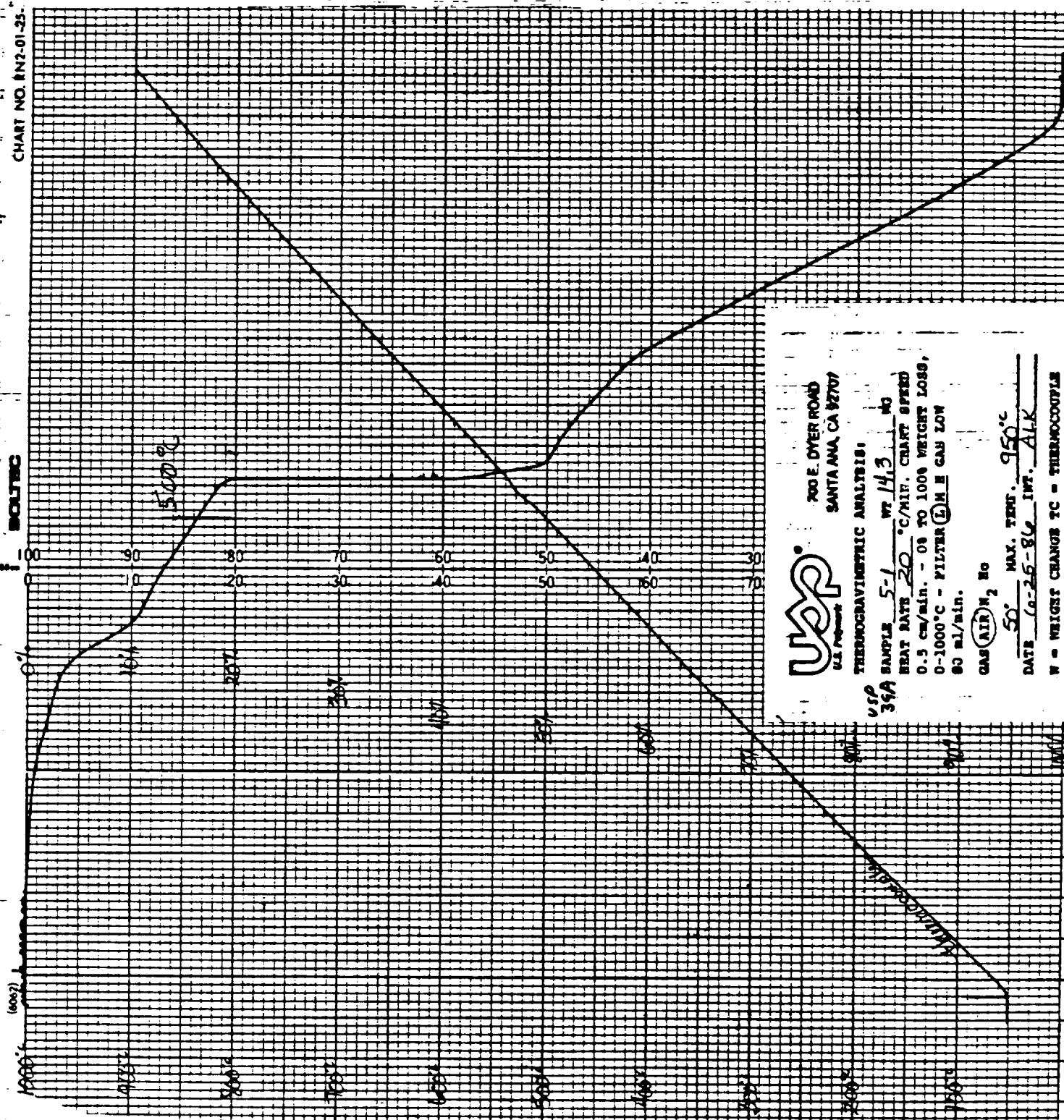
Page #24





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OF POOR QUALITY

CHART NO. IN2-01-25.



U.S.P.
U.S. Pharmacopeia
200 E. Dyer Road
Santa Ana, CA 92707

THERMOGRAVIMETRIC ANALYSIS

36A SAMPLE 5-1 WT 14.3 MG
HEAT RATE 20 °C/MIN. CHART SPEED
0.5 CM/MIN. - 0% TO 100% WEIGHT LOSS
0-1000°C - FILTER @ 1M 2 GM/L
80 ml/min.

gas AIR N₂ No

50° MAX. TEMP. 950°
DATE 02-25-84 INT. ALK

W = WEIGHT CHANGE TC = THERMOCOUPLE

GPC CALIBRATION PLOT

Page #27

*** Calibration Data ***

Calibration Name:

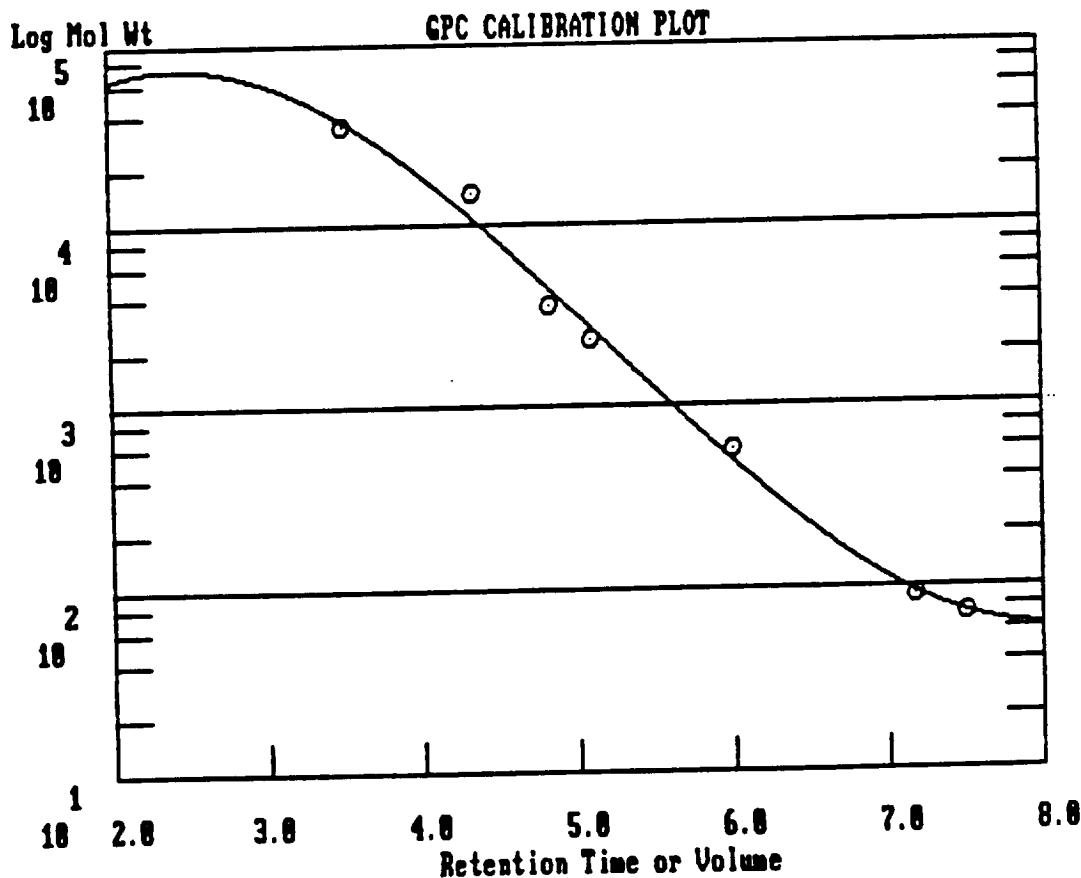
Misc Information:

Fit Type: 3

$$\text{Log Mol Wt} = A + Bx + Cx^2 + Dx^3$$
$$A = 2.538977 \quad B = 2.115815 \quad C = -0.5646824 \quad D = 3.606432E-02$$
$$\text{Coefficient of Determinations: } 0.9902$$

Coefficient of Determinations: 0.9902

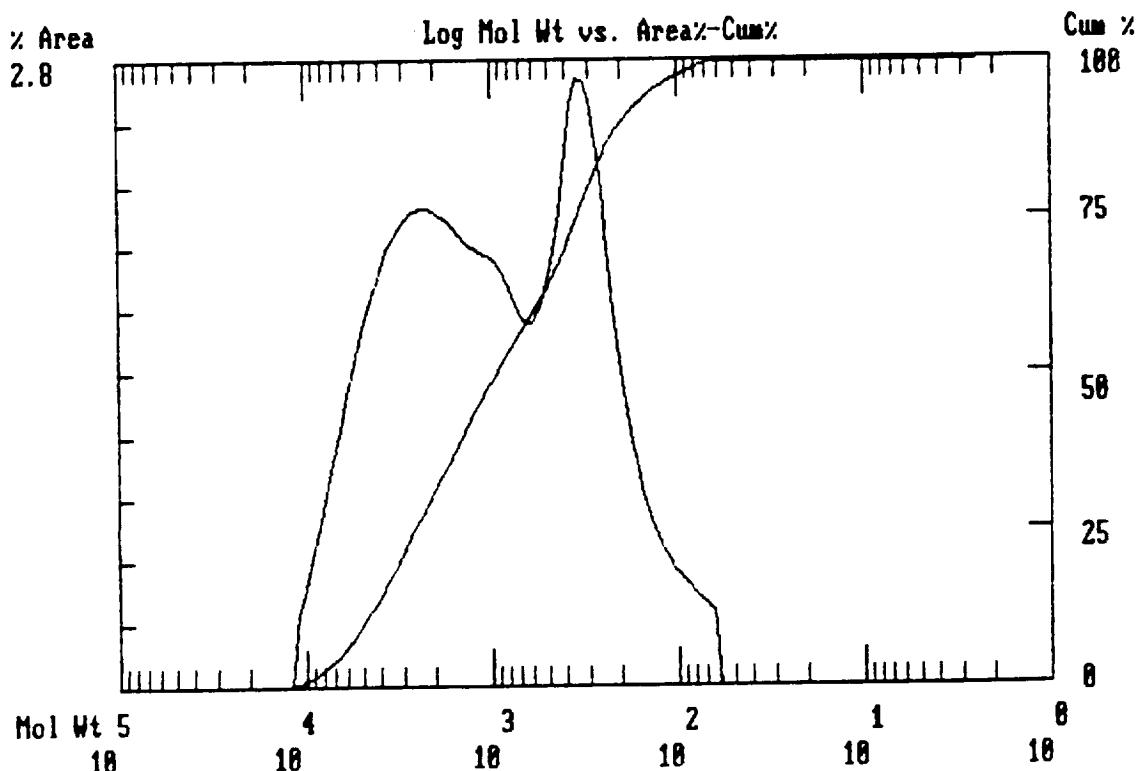
Ret Time	Molecular Weight	Log Mol Wt
3.50	35000	4.544
4.33	15000	4.176
4.83	3600	3.556
5.09	2350	3.371
6.00	570	2.756
7.17	92	1.964
7.50	72	1.857



***** GPC REPORT *****

* Sample Name: 91LD 1-1 C=2.68 Operator Initials: GBF
* Date: 08-05-1986 13:16:30 Method:
* Interface: 5 Cycle#: 25 DATA FILE: B:GPC25 .PTS
* Starting Peak Width: 60 Threshold: 0 Channel#: 0 Vial#: N.A.
*
* Instrument Type: HPLC/BECKMAN Column Type: ULTRASTYRAGEL 500A
* Solvent Description: THF
* Operating Conditions: T=35C FLOWRATE=2.0ML/MIN
* Detector 0: 254NM/.1AU Detector 1:
* Misc. Information: CALIBRATION/GPC

Starting Delay: 0.00 Ending Retention Time: 10.00
Calibration file: GFCPHEN
Molecular Weight Distribution Averages
Baseline TIMES: 3.85 to 10.00 MW: 22295 to 2
Process TIMES: 3.85 to 10.00 MW: 22295 to 2
Total Area: 153894
n_w= 1770
M_n= 462
w/M_n= 3.8293
z= 4175
M_v= 1555



DATA FILE A:GPC31.HDR TAKEN 08-05-1986 17:39:57

***** GPC REPORT *****

Sample Name: USP79A 1-1=2.68 Operator Initials: GBF *
* Date: 08-05-1986 15:00:24 Method: *
* Interface: 5 Cycle#: 31 Channel#: 0 Vial#: N.A. *
Starting Peak Width: 60 Threshold: 0 *

* Instrument Type: HPLC/BECKMAN Column Type: ULTRASTYRAGEL 500A *

Solvent Description: THF *

Operating Conditions: T=35C FLOWRATE=2.0ML/MIN *

* Detector 0: 254NM/.1AU Detector 1: *

Misc. Information: CALIBRATION/GPC *

Starting Delay: 0.00 Ending Retention Time: 10.00

Calibration file: GPCPHEN

Molecular Weight Distribution Averages

Baseline TIMES: 3.85 to 10.00 MW: 22295 to 2

Process TIMES: 3.85 to 10.00 MW: 22295 to 2

Total Area: 211188

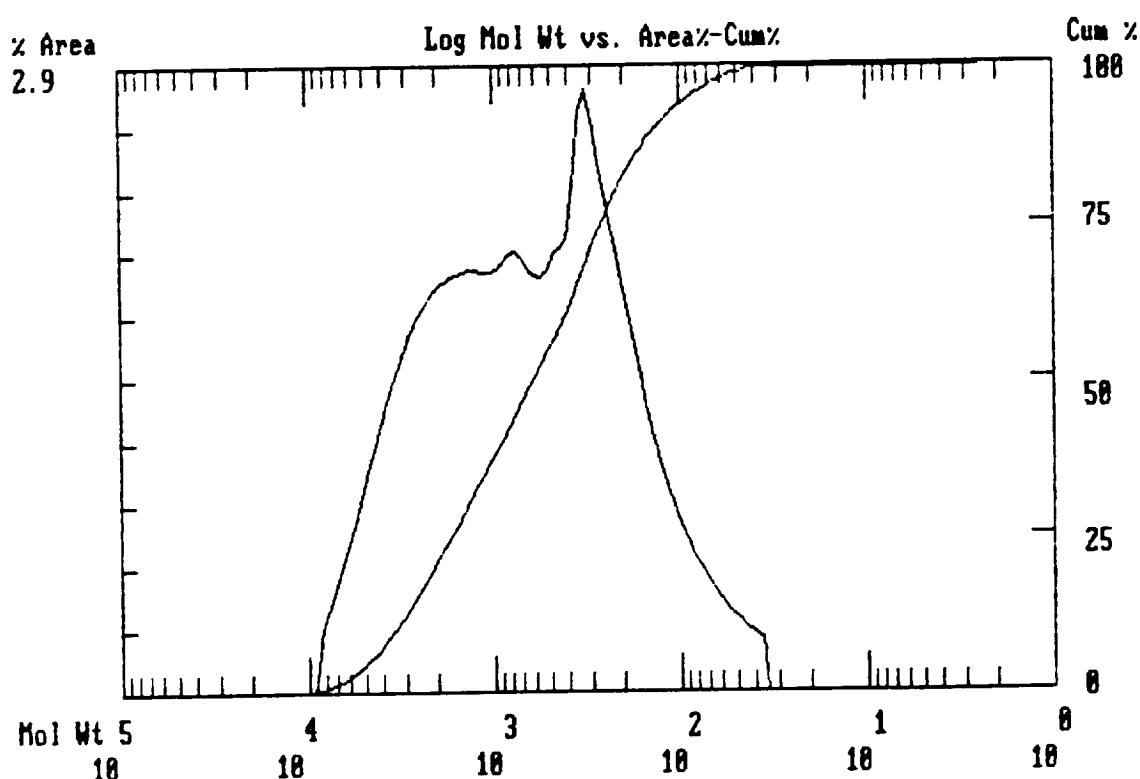
lw= 1231

Mn= 312

1w/Mn= 3.9362

lz= 3069

Mv= 1076



***** AREA PERCENT REPORT *****

* Sample Name: 91LD,1-2,C=6.80 Operator Initials: JGZ *
* Date: 09-06-1986 08:54:02 Method: PHENOLIC DATA FILE: A:PHENO41.FTS *
* Interface: 0 Cycle#: 41 Channel#: 0 Vial#: N.A. *
* Starting Peak Width: 10 Threshold: 1 *

Instrument Type: BECKMAN HPLC Column Type: MICROBONDFAK C-18 *
* Solvent Description: THF/WATER, 2:1 BY WEIGHT *
* Operating Conditions: R.T., FLOWRATE=1.5 ML/MIN *
Detector 0: 220NM/.5AU Detector 1: *
* Misc. Information: LENGTH=25 *

Starting Delay: 0.00 Ending Retention Time: 10.00

Pk No.	Ret Time	Peak Area	Area %	B L	Peak Ht.	Normalized %	Area/ Height
2	1.82	121318	64.1205	2	5979	100.000	20.3
3	1.98	21021	11.1102	2	4292	17.327	4.9
4	2.08	46864	24.7693	2	4890	38.629	9.6

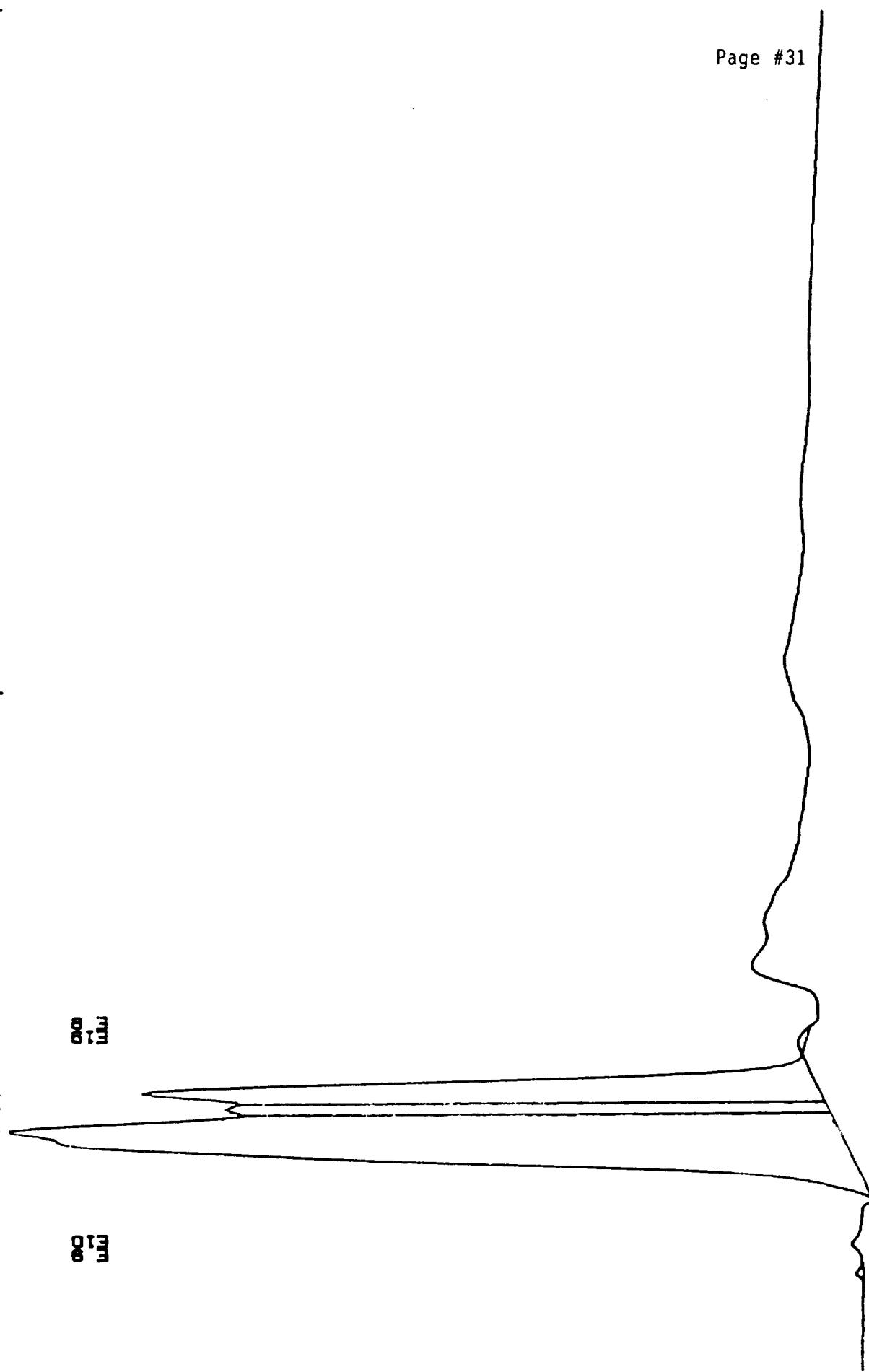
Total Area: 189203 Area Reject: 1000 One sample per 1.000 sec.

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DATA FILE=PHEND41 FROM 0.00 MIN. TO 10.00 MIN. LOW SCALE= 5. 388 Mv. HIGH SCALE= 11. 634 Mv.
81 LD, 1-2, C=6.80 MG/ML. 9/6/86. JGZ

N 800
600
400
200

800
600
400
200



DATA FILE A:PHENO20.HDR TAKEN 09-01-1986 15:13:56

***** AREA PERCENT REPORT *****

* Sample Name: USP39A,2-1,C=5.555 Operator Initials: JGZ
* Date: 09-01-1986 15:13:56 Method: PHENOLIC DATA FILE: A:PHENO20.PTS
* Interface: 4 Cycle#: 20 Channel#: 0 Vial#: N.A.
* Starting Peak Width: 10 Threshold: .01

* Instrument Type: BECKMAN HPLC Column Type: MICROBONDFAK C-18
* Solvent Description: THF/WATER, 2:1 BY WEIGHT
* Operating Conditions: R.T., FLOWRATE=1.5 ML/MIN
* Detector 0: 220NM/.5AU Detector 1:
* Misc. Information: LENGTH=25

Starting Delay: 0.00 Ending Retention Time: 10.00

Pk No.	Ret Time	Peak Area	Area %	B L	Peak Ht.	Normalized %	Area/ Height
1	0.73	2256	1.2208	1	562	2.392	4.0
2	1.82	94314	51.0355	2	5417	100.000	17.4
3	1.97	29598	16.0160	2	5094	31.382	5.8
4	2.07	58633	31.7278	2	5278	62.168	11.1

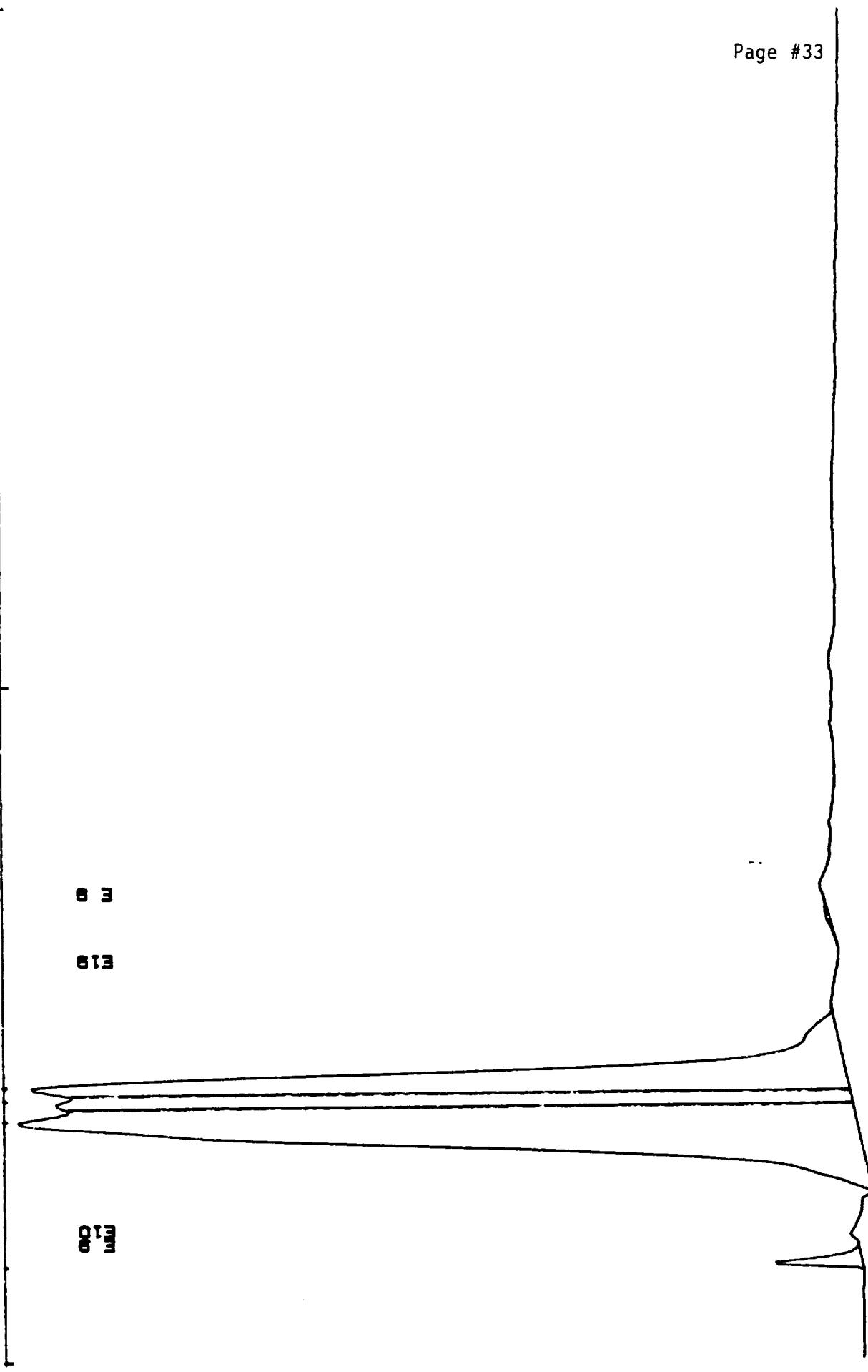
Total Area: 184801 Area Reject: 1000 One sample per 1.000 se

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DATA FILE-PHEN020 FROM 0.00 MIN. TO 10.00 MIN. LOW SCALE- 5.401 MV. HIGH SCALE- 10.830 MV.
USP-38A, 2-1, C=5, 555 MG/ML, 8/2/86, JGZ

D.73
1.62
2.40

63
E18
00
MV



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TYPICAL GAS CHROMATOGRAPH SET-UP

Operator	D.S.Z.	Date	12/16/86
Column		Detector	FID
Length	6 ft.	Voltage	
Dia.	1/4 in.	Sensit.	
Liquid Phase	AT-1000	Flow Rates, ml/min	
Wt. %	0.1	Hydrogen	60
Support	GRAPHPAC	Air	76
Mesh	80/100	Scavenge	
Carrier Gas	He	Split	
Rotameter		Temperature, °C	
Inlet Press	602 psig	Det.	220
Rate	30 ml/min	Inj.	200
CHART SPEED		Column Initial	60
SAMPLE	USP 39A, 5-	Final	210
Size	0.05 ml	Rate	50 cm/min
		Solvent	THF
		Concn.	0.1522 g/ml

GAS CHROMATOGRAPHY STANDARD SOLVENT

TEST METHOD CTM-55

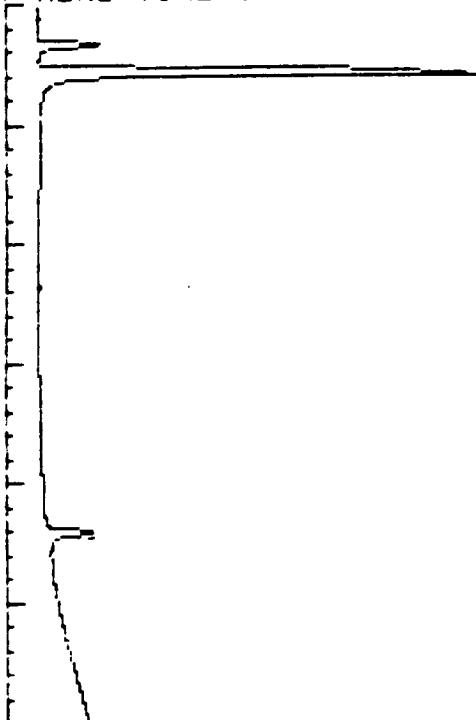
STANDARD SOLVENT/MONOMERRETENTION TIME (MINS.)

MEOH	.6
ETHANOL	1.18
MECL2	1.28
ACETONE	1.45
IPA	1.83
THF	3.08
ACETONITRILE	3.2
CRESOL	4.03
MEK	4.08
FURFURAL	15.03
TOLUENE	17.98
CHLOROBENZENE	19.6
PHENOL	22.08

NOTE: THF WAS USED TO DILUTE THE RESIN SAMPLES.

VERTICAL SCALE FACTOR 1%

*** REAL TIME CHROMATOGRAM ***



FINAL FULL SCALE MV.=1000.00

SAMPLE: 91 LD 2-1
MISC.: C=0.101781 GMS/ML

TIME: 11:49
DATE: 12/10/86
OPERATOR: JGZ

RUN TIME: 30.00 MINUTES
DELAY TIME: 0.00
CHAN: 0

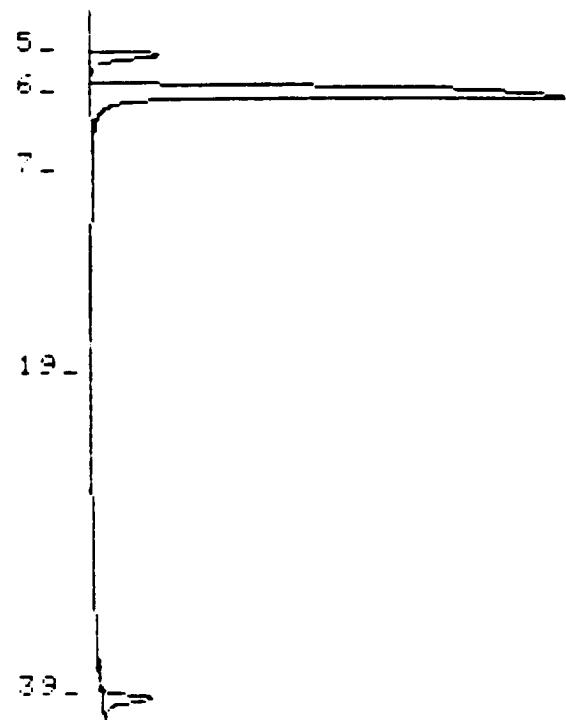
PK NO.	RET TIME	PEAK AREA	AREA %	AREA L	PEAK HT.
2	1.65	1789	.075	2	235
5	1.70	204140	8.568	2	11953
6	3.05	2010900	84.397	3	84306
7	5.55	1537	.065	4	127
19	11.90	2214	.093	2	96
39	22.05	162080	6.802	1	8700

TOTAL AREA= 2382661

THRESHOLD= 1

MIN PK WIDTH= 15

AREA REJECT= 1000



SAMPLE: 91 LD 2-1
MISC.: C=0.101781 GMS/ML

TIME: 11:49
DATE: 12/10/86
OPERATOR: JGZ

RUN TIME: 30.00 MINUTES
DELAY TIME: 0.00
CHAN: 0

PK NO.	RET TIME	PEAK AREA	AREA %	AREA L	PEAK HT.
--------	----------	-----------	--------	--------	----------

5	1.70	204140	8.568	2	11953
6	3.05	2010900	84.394	3	84306
39	22.05	162080	6.818	1	8700

TOTAL AREA= 2377120

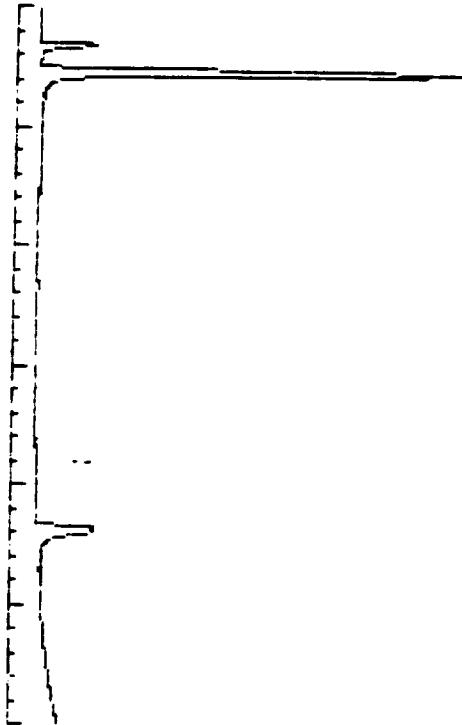
THRESHOLD= 1

MIN PK WIDTH= 15

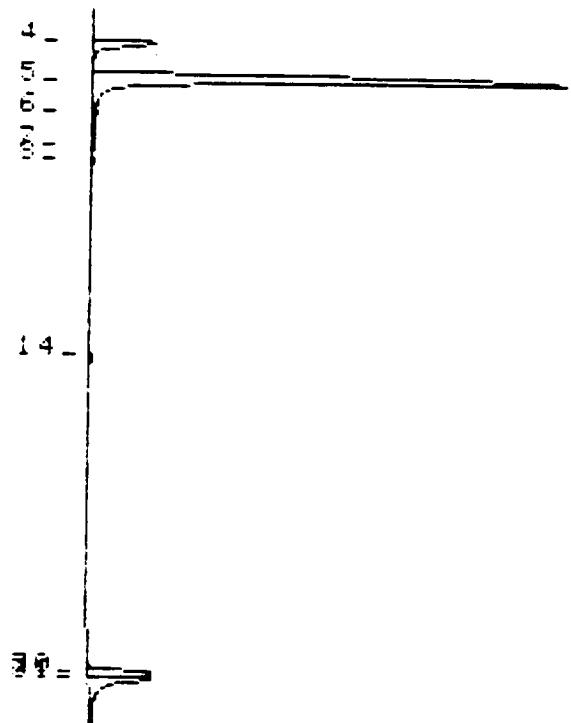
AREA REJECT= 2300

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*** REAL TIME CHROMATOGRAM ***



VERTICAL SCALE FACTOR: 1X



FINAL FULL SCALE MV.=1000.00

SAMPLE: UEF398 4-2
MISC.: C=0.10199 GMS/ML

TIME: 14:04
DATE: 12/16/86
OPERATOR: JGZ

RUN TIME: 30.00 MINUTES
DELAY TIME: 0.00
CHAN: 0

PK NO.	RET TIME	PEAK AREA	AREA %	B L	PEAK HT.
4	1.65	139370	7.563	2	10853
5	2.90	1343400	72.896	3	81323
6	3.88	16833	1.913	4	843
7	4.88	2075	1.113	4	123
8	5.48	2769	1.50	3	235
14	11.65	9910	0.538	1	512
30	21.85	121440	6.590	2	10620
31	22.03	207110	11.238	2	10643

TOTAL AREA= 1842907
THRESHOLD= 1
MIN.PK.WIDTH= 15
AREA REJECT= 1000

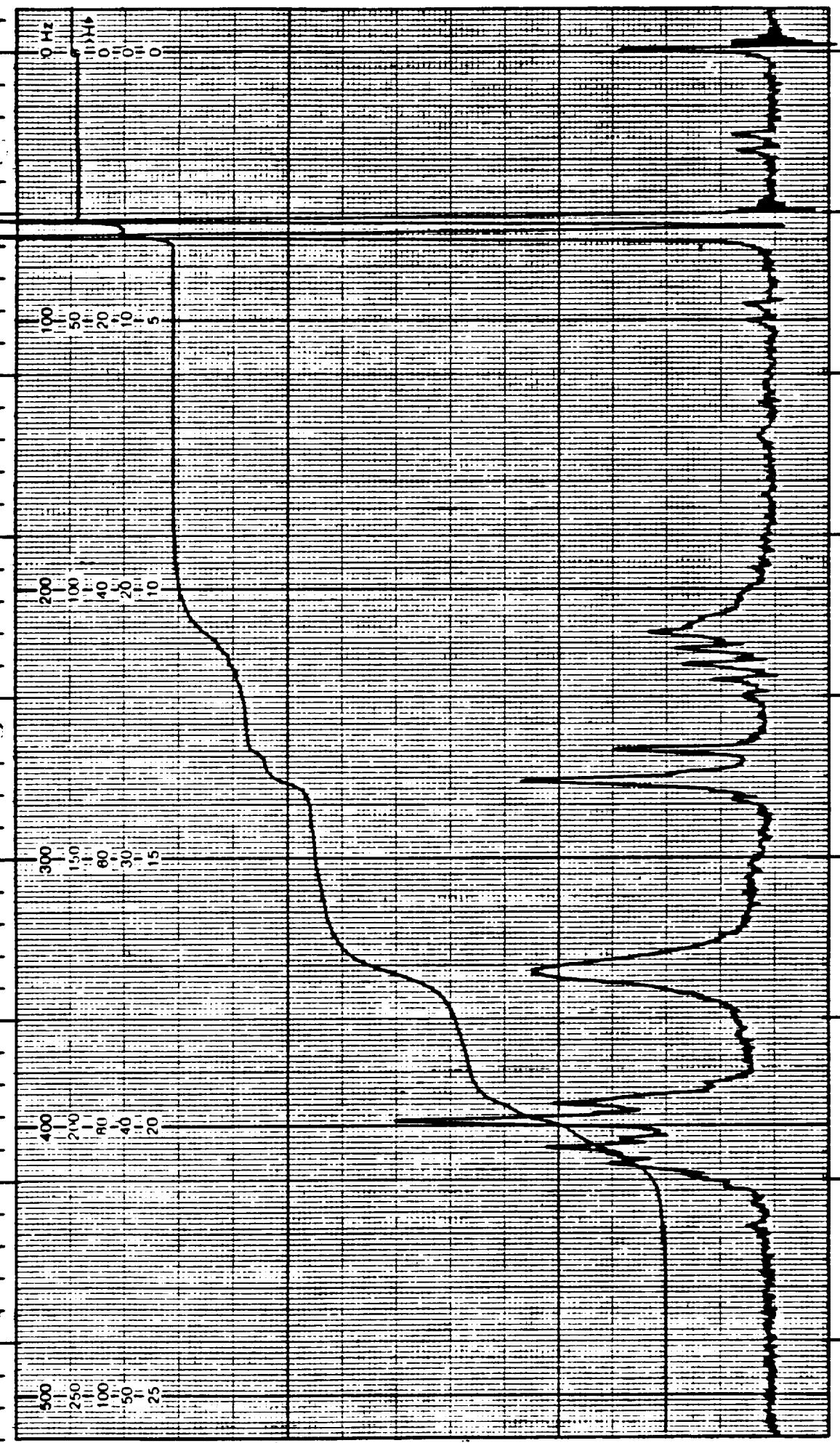
SAMPLE: UEF398 4-2
MISC.: C=0.10199 GMS/ML

TIME: 14:04
DATE: 12/16/86
OPERATOR: JGZ

RUN TIME: 30.00 MINUTES
DELAY TIME: 0.00
CHAN: 0

PK NO.	RET TIME	PEAK AREA	AREA %	B L	PEAK HT.
4	1.65	139370	7.694	2	10853
5	2.90	1343400	74.167	3	81323
30	21.85	121440	6.705	2	10620
31	22.03	207110	11.434	2	10643

TOTAL AREA= 1811320
THRESHOLD= 1
MIN.PK.WIDTH= 15
AREA REJECT= 17000



9162
 0.136 gm sample
 0.775 gm solvent
 Page #37
 Lot # 2-3
 SPECTRUM NO.
 9162
 DATE: 2-21-76
 OPERATOR: DFW
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SWEEP OFFSET (Hz): 0
 SPECTRUM AMPLITUDE: 8.0
 INTEGRAL AMPLITUDE: 5.0
 SPINNING RATE (RPS): 2

RF POWER LEVEL: 0.25
 FILTER: (1) (1) (1) (1)
 SWEEP WIDTH (Hz): 1000
 SWEEP TIME (SEC): 1000
 DEC. LEVEL: (2)
 DEC. LEVEL: (500)

MANUAL

AUTO

NORELL, INC.
 LANDISVILLE, N.J. 08326

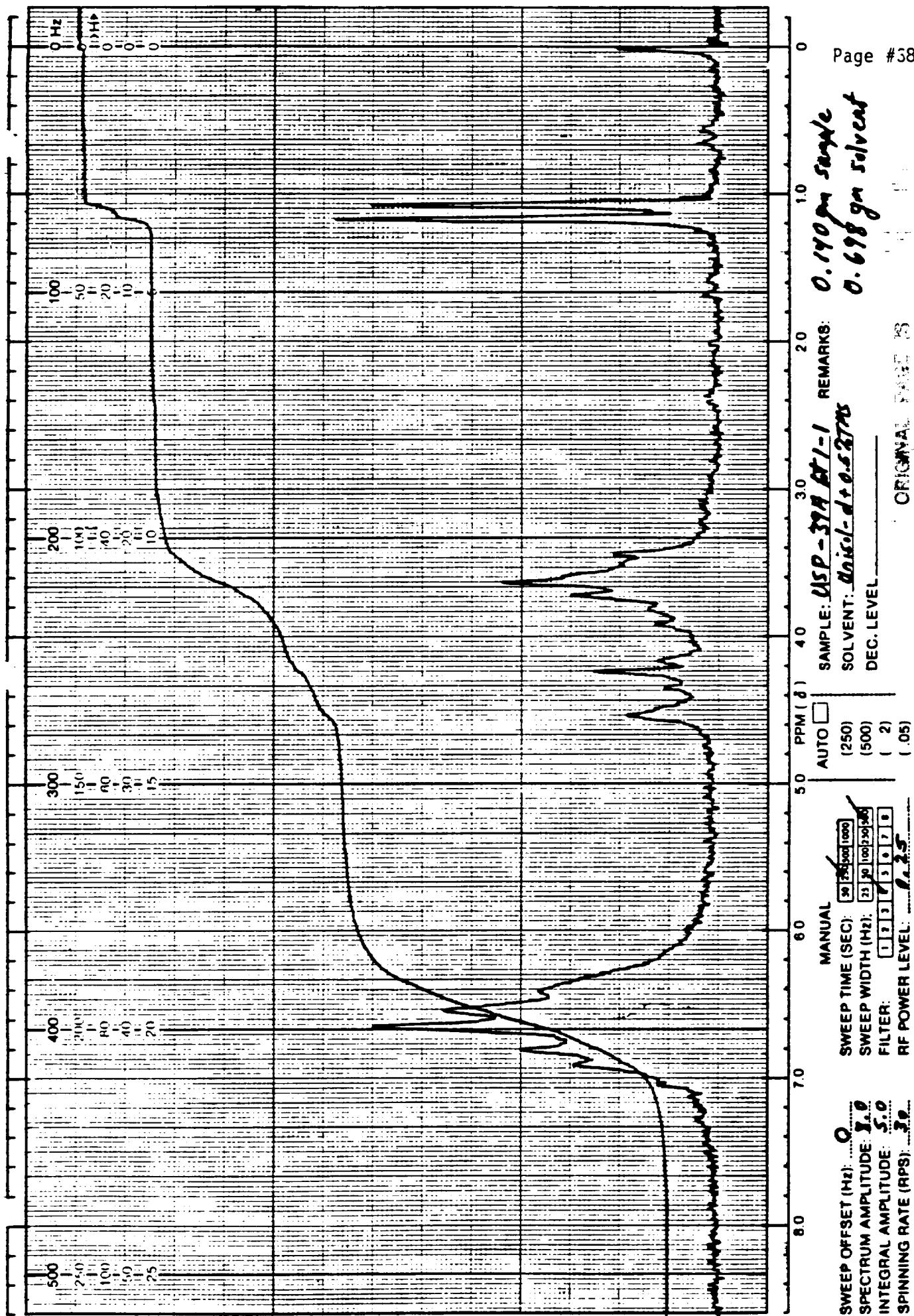
5100-502-002
 5100-502-003

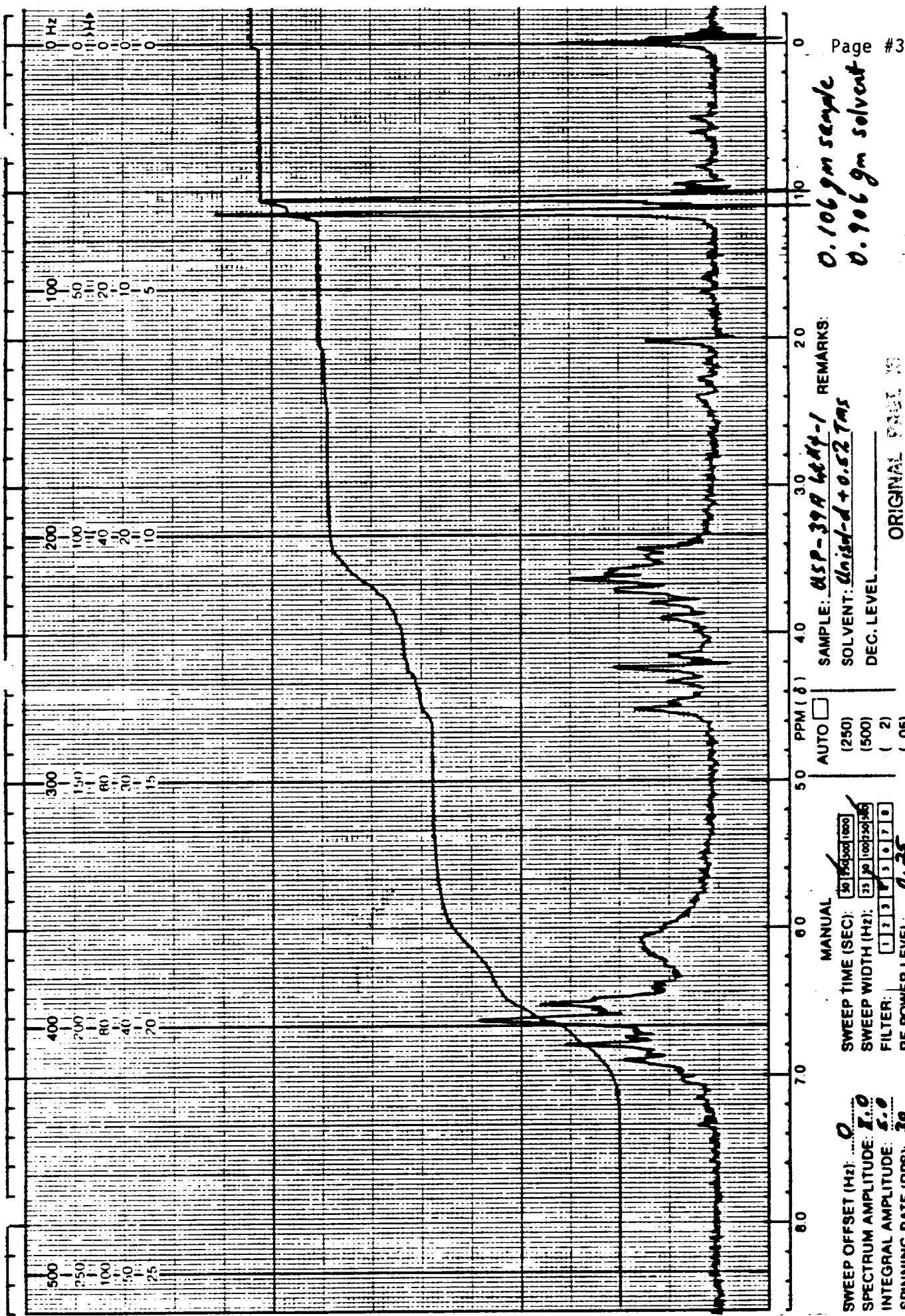
0.140 gm sample
0.698 gm solvent

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OF POOR QUALITY

SPECTRUM NO. 152-394
DATE: 3-21-86
OPERATOR: DSW

NORELL, INC.
LANDISVILLE, N.J. 08326
Phone: (609) 697-0020





Page #39

SAMPLE: HSP-39A lot #4-1
SOLVENT: ~~Chloro-d₄~~ + 0.527m
DEC. LEVEL

ORIGINAL

SPECTRUM NO.
OF POOR QUALITY

MANUAL
SWEEP TIME (SEC): 30.000000
 3.000000
SWEEP WIDTH (Hz): 333000000
 33300000
FILTER: 1.000000
 0.700000
RF POWER LEVEL: 0.25

DATE: 2-21-86

NORELL, INC.
LANDISVILLE, N.J. 08326

OPERATOR: DFW

HSP-39A
lot #4-1

NORELL, INC.
LANDISVILLE, N.J. 08326
160 Phone: (609) 697-0020

DATE: 6-19-76

OPERATOR: DGM

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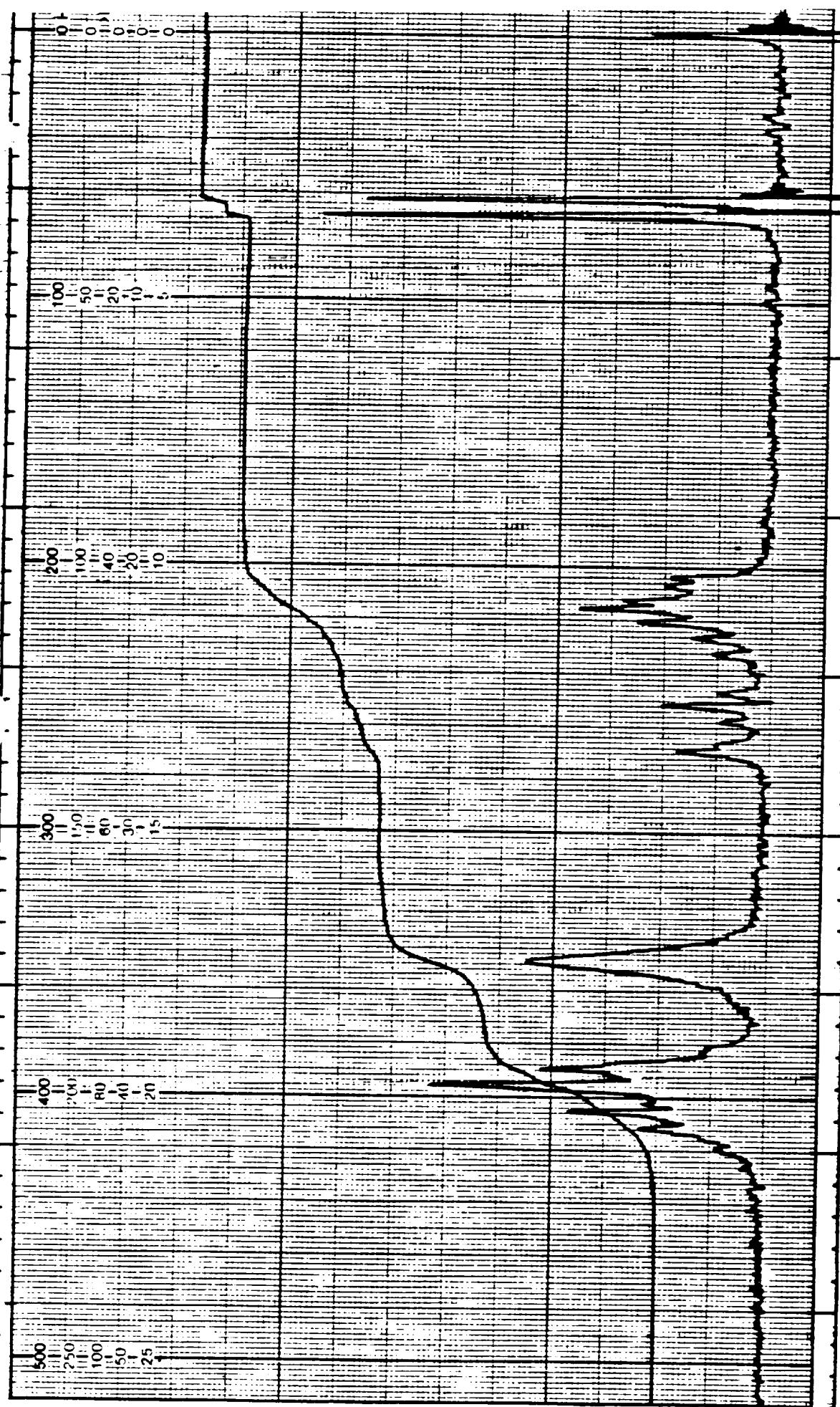
Page #40

SAMPLE: USP-399 lot 5-1 REMARKS: 0.153 gm sample
SOLVENT: dimethylsulfone
DEC. LEVEL: 0.917 gm solvent

SAMPLE: USP-399 lot 5-1 REMARKS: 0.153 gm sample
SOLVENT: dimethylsulfone
DEC. LEVEL: 0.917 gm solvent

SWEET OFFSET (Hz): 0
SPECTRUM AMPLITUDE: 1.0
INTEGRAL AMPLITUDE: 5.0
SPINNING RATE (PPM): 30

MANUAL
SWEEP TIME (SEC): 30 (1 sec/sec)
SWEEP WIDTH (Hz): 25 (100-250 Hz)
FILTER: 1 7 3 1 1 3 0 7 0
RF POWER LEVEL: 0.30



USP-399
lot 5-1

TABLE OF CONTENTS

FABRIC TESTING

NAS8-36298

U.S. Polymeric O.E. 71108

	<u>PAGE</u>
I. SAMPLING PLAN.....	1
II. TEST METHODS AND OBSERVATIONS.....	2
A. Carbon, Hydrogen and Nitrogen Assay.....	2
B. Areal Weights and Volatiles.....	2
C. Specific Gravity.....	4
D. Filament Diameters.....	4
E. Thread Count.....	4
F. Breaking Strength.....	5
G. Thermal Gravimetric Analysis (TGA).....	5
H. Atomic Absorption (AA).....	6
I. pH.....	7
III. SUMMARY.....	7

TABLES AND CHARTS

Comparative Fabric Data.....	8
CCA-3 Test Results.....	11
CCA-3 Statistical Summary.....	14

	<u>PAGE</u>
SWB-8 Test Results and Statistical Summary.....	15
WCA Test Results and Statistical Summary.....	18
PWB-6 Test Results.....	21
PWB-6 Statistical Summary.....	24
Typical Visual Inspection Results.....	25
Chart of Weight Variations.....	29
Typical TGA Charts.....	30

FABRIC TESTING

COMMENTS AND OBSERVATIONS

NAS8-36298

I. SAMPLING PLAN

The four fabrics utilized for this project were sampled for testing during the visual inspection which was conducted on each roll. Typical examples of the inspection reports are included on pages #25 through #28, while copies of the inspection reports for each individual roll are included in the appropriate prepreg fingerprint. The rayon-based fabrics, CCA-3 and WCA, were delivered in nominal full rolls of 90-100 pounds and the rolls were approximately 150-180 yards of 44-inch wide fabric. Samples were taken from the start and the end of each of these rolls with each test sample representing approximately 90 yards of rayon-based fabric. All test lots (20 lbs.) contained only 20 yards of fabric; and in these cases, only single fabric samples were taken for fabric characterization.

The PAN-based fabrics, SWB-8 and PWB-6, were delivered in nominal full rolls of 10-20 pounds containing approximately 20-40 yards of 33-inch wide fabric. Samples were taken only from the start of these rolls with each sample representing about 30 yards of PAN-based fabric. For PWB-6, the production run for the second lot of FM 5839 using fabric sample #2R-1 was out of specification in resin content and could not be used to satisfy the prepreg testing requirement. This resulted in a second production run utilizing fabric sample #2-14 which was acceptable. Results of fabric testing on both of these fabric samples have been included in the fabric statistical averages.

Fabric samples were maintained at ambient conditions in open plastic bags until all testing was completed. The sequence of sample numbers followed the prepregging sequence of rolls but does not exactly correspond to the prepreg roll numbers. For example, only 10 of the 13 fabric rolls characterized for SWB-8 Lot #2 were utilized to produce 7 rolls of prepreg for FM 5834 Lot #2. Therefore, each roll of prepreg contained 1+ rolls of raw fabric with 3 fabric rolls characterized, but not utilized for production. Comparative fabric data is summarized on pages #8 through #10, with individual fabric data on pages #11 to page #24.

II. TEST METHODS AND OBSERVATIONS

A. Carbon, Hydrogen and Nitrogen Assay

A LECO carbon, hydrogen and nitrogen analyzer, Model CHN-600, was used to determine the assay values. The lower carbon assay and higher nitrogen assay of CCA-3 shown on page #11 are typical due to the lower firing temperature. No other significant trends were observed.

B. Areal Weights and Volatiles

Initial weights were taken of 4 in. x 4 in. squares of each fabric as received, after several months storage at ambient conditions. Of particular importance is the large standard deviation of the weights of spun PAN fabrics, 0.26 gms. for SWB-8 and 0.18 gms. for PWB-6, compared to the continuous rayon fabrics, 0.08 gms. for CCA-3 and 0.05 gms. for WCA. This large variability of spun PAN fabrics (3-4 times that of continuous rayon precursors) was observed in several fabric physical measurements due to the structure of spun PAN yarns and methods of fabric manufacture. Other in-process data, not included in the fingerprint characterization, but summarized on the chart on page #29 indicate that the variation in weight between sides of the fabric roll, left and right,

compared to the center width of the roll was 2.5-3 times higher on the spun PAN fabrics and also indicate that maximum fabric weight variation between the start and the end of the same fabric roll averaged only 6-7% in continuous rayon precursors and 24-26% variation for the spun PAN precursors. Considering 180-yard average roll length for the rayons versus the 40-yard rolls for spun PAN, this weight variation for PAN fabrics appears to be excessive.

The fabrics specimen were then dried in an air circulating oven set at 325°F for 15 minutes, and the weight change used to indicate volatile content. It should be noted that in a pretreating step in impregnation, all fabrics are dried, so that all fabrics, including CCA-3, enter the impregnation step at lower volatile levels than this data indicates. For convenience, the unit conversions for average dry areal weights are given below:

DRY AREAL WEIGHTS

<u>FABRIC TYPE</u>	<u>OZ. PER SQ. YD.</u>	<u>GMS. PER SQ. METER</u>
CCA-3	8.00	271.1
SWB-8	9.28	314.7
WCA	7.17	243.1
PWB-6	6.91	234.3

In the final step in the areal weight test method, the samples were washed with acetone and redried. This procedure is standard for calculation of the percent of sizing applied primarily to glass fibers but for carbon and graphite where no sizing is used, the test results were inconclusive and have no particular application.

C. Specific Gravity

A helium pycnometer was used to determine specific gravity. The results for CCA-3 are unreliable due to the surface activity of carbon fibers, fired at a lower temperature. Expected values for CCA-3 would be in the range of 1.84 rather than the 2.95 observed. The specific gravities obtained of the other fabrics were all higher than expected.

SPECIFIC GRAVITY

<u>FABRIC TYPE</u>	<u>EXPECTED</u>	<u>OBTAINED</u>
CCA-3	1.84	2.95
SWB-8	1.76	1.89
WCA	1.44	1.64
PWB-6	1.75	1.81

D. Filament Diameters

Warp filaments were surveyed for each fabric sample with 10 representative individual filaments being measured using scanning electron microscopy (SEM). Filament diameters in the fill direction were measured, also with 10 filaments being surveyed, but only for one sample per fabric lot and type. Results indicated no significant differences in diameters between warp and fill filaments, and all were within 9-10 micron range regardless of the fabric type.

E. Thread Count

Using a thread counting apparatus with an optical magnifier, the number of yarns per inch was averaged for five individual readings in both warp and fill directions. For SWB-8, due to the irregular filament

directions and the tight weave, the optical thread count was difficult to determine and was verified by a physical separation and counting of yarns. Once more, the standard deviation in thread counts for spun PAN fabric were 3-5 times higher than their corresponding weave in continuous rayon precursors. Also notable is WCA, the only fabric in this study which is not a balanced weave (i.e., a different number of yarns in the warp and fill directions). Even though WCA is a square weave, (one over and one under) the 29 warp by 21 fill yarns are the main contributors to the roughly 2 to 1 directional breaking strength (48 lbs./inch warp to 20 lbs./inch fill) (page #19).

F. Breaking Strength

A one-inch wide, cut fabric strip was stressed in the universal test machine to determine the raw fiber breaking strength values in pounds. All fabrics had roughly balanced breaking strengths except WCA, where the main contributor to the unbalanced breaking strength is the unbalanced thread count. The variation (standard deviation) in breaking strength for spun PAN fabrics is, in most cases, higher than the corresponding rayon precursor for equivalent weave patterns.

G. Thermal Gravimetric Analysis (TGA)

Two different equipment set-ups were utilized at U.S. Polymeric to test weight loss in air versus temperature, for fabric samples. Set-up #1 consisted of a Perkin-Elmer model TGS-2 thermal analyzer with a DSC programmer which contained only a programmed heating rate. Equipment set-up #2 used an identical TGS-2 thermal analyzer with a Perkin-Elmer System IV controller with a feedback loop in addition to a programmed heat rate. For data comparison purposes, the temperature in °C at which 50% of the weight loss had occurred, was selected to give a point approximately half-way down the steep portion of the curve. Note:

equipment set-up #1 consistently gave 60°C higher temperatures for the 50% weight loss than equipment set-up #2, since the pyrolysis became partly exothermic, and the feedback loop on the system IV controller sensed the exotherm and reduced the heat input, while set-up #1 continued with the programmed heating rate.

The higher firing temperature of WCA tended to give most stable TGA on both set-ups (i.e., longer to show 50% weight loss), while the spun PAN fabrics were 50°C below WCA. The lowest fired fabric, CCA-3, gave the least stable TGA, as expected. Concerning individual variations (standard deviation) in the temperatures, spun PAN's were generally more variable than their rayon equivalent. Typical plots for each fabric for each equipment set-up are included in pages #30 through #37. The graphs for each fabric sample are included only in the appropriate prepreg lot fingerprint.

H. Atomic Absorption (AA)

The ash from a 600°C (1,112°F) pyrolysis occurring over 16-20 hours was digested using hydrochloric acid and compared for light absorption with accurately prepared alkaline metal standards at 0.5 ppm. Of particular note is the higher overall levels of sodium, potassium, and magnesium in CCA-3 accompanied by very low levels of calcium. The two spun PAN fabrics appeared similar to each other in alkaline metal levels and are noticeably higher in calcium levels than their equivalent rayon based precursors. Finally, the WCA which has the highest firing temperature has the lowest alkaline metal content of all fabrics tested. As a sidelight, it is estimated that if the rayon purity received by HITCO and AMOCO were maintained and the fabrics fired without any further purification during processing steps, the alkaline content would be in the 3000-4000 ppm range.

As an adjunct to the AA testing, the weight loss after 2 hours at 125°C (257°F) showed the expected higher volatile loss for CCA-3 due to its hydroscopic nature, and ash levels after 16-20 hours at 60°C (1,112°F) were as expected.

I. pH

The pH was determined on duplicate fabric samples boiled in distilled water for 20-30 minutes and allowing the solution to reach room temperature prior to testing. Of particular note is the relative consistency of the pH of WCA on page #20 and the pH levels of 10.00 or higher on samples #4-11, 4-12, and 4-13 of PWB-6 fabric (page #23). These three samples of PWB-6 were obtained from a different manufacturer's lot from samples #4-1 through 4-10. Their pH reflects some process variations at the point of manufacture. STACKPOLE FIBERS was unable to provide the required quantities of PWB-6 from one manufacturing lot. There is no verified explanation for the pH differences between PWB-6 and SWB-8.

III. SUMMARY

The fabric testing conducted on this contract verified the suspected variability of spun PAN fabrics compared to their continuous rayon precursors with equivalent weaves. The areas of high variations included areal weight, variations, thread counts, breaking strengths, and TGA's. Some of the variability of spun PAN fabrics can be tracked through to variations in the physical properties of cured prepreg panels.

COMPARATIVE FABRIC DATA

Page #8

NAS8-36298

FABRICS FOR CARBON/PHENOLIC PREPREGS

=====

CCA-3

=====

				AS RECVD. 4 X 4		INIT. ACETONE SPECIF.		
GRAND TOTAL	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 DRY WEIGHT grams	WEIGHT grams	VOLS. %	CHANGE %	GRAVITY units
AVERAGE	96.85	0.140	0.836	2.962	2.799	5.50	-0.38	2.949
STD DEV	0.41	0.014	0.077	0.079	0.045	1.39	0.89	0.385
MINIMUM	95.97	0.113	0.600	2.826	2.697	2.01	-3.23	2.238
MAXIMUM	97.80	0.170	1.000	3.132	2.896	8.60	0.70	3.939

SWB-8

=====

				AS RECVD. 4 X 4		INIT. ACETONE SPECIF.		
GRAND TOTAL	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 DRY WEIGHT grams	WEIGHT grams	VOLS. %	CHANGE %	GRAVITY units
AVERAGE	99.63	0.007	0.120	3.262	3.249	0.41	-0.15	1.892
STD DEV	0.19	0.007	0.053	0.264	0.263	0.04	0.09	0.229
MINIMUM	99.27	0.001	0.001	2.799	2.788	0.35	-0.32	1.632
MAXIMUM	99.90	0.027	0.200	3.694	3.679	0.51	0.03	2.380

FABRICS FOR CARBON/CARBON PREPREGS

=====

WCA

=====

				AS RECVD. 4 X 4		INIT. ACETONE SPECIF.		
GRAND TOTAL	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 DRY WEIGHT grams	WEIGHT grams	VOLS. %	CHANGE %	GRAVITY units
AVERAGE	99.62	0.006	0.117	2.520	2.509	0.42	0.06	1.644
STD DEV	0.13	0.006	0.068	0.051	0.049	0.11	0.12	0.029
MINIMUM	99.40	0.001	0.037	2.441	2.430	0.27	-0.11	1.610
MAXIMUM	99.87	0.023	0.333	2.602	2.589	0.60	0.29	1.719

PWB-6

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				AS RECVD. 4 X 4		INIT. ACETONE SPECIF.		
GRAND TOTAL	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 DRY WEIGHT grams	WEIGHT grams	VOLS. %	CHANGE %	GRAVITY units
AVERAGE	99.86	0.006	0.088	2.433	2.419	0.59	-0.05	1.809
STD DEV	0.04	0.005	0.036	0.181	0.181	0.15	0.10	0.028
MINIMUM	99.77	0.001	0.010	2.194	2.176	0.30	-0.29	1.750
MAXIMUM	99.90	0.017	0.133	3.017	3.002	0.83	0.07	1.857

COMPARATIVE FABRIC DATA

NAS8-36298

FABRICS FOR CARBON/PHENOLIC PREPREGS

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CCA-3

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	FILAMENT GRAND TOTAL	FILAMENT DIAMETER microns	THREAD DIAMETER WARP FILL microns	THREAD COUNT WARP FILL ---per inch---	BREAK STRENGTH WARP lbs.	BREAK STRENGTH FILL lbs.	#1 TGA 50% WT. LOSS °C	#2 TGA °C
AVERAGE	10.69	11.53	52.3	49.0	34.4	25.5	676	588
STD DEV	1.35	1.29	0.5	0.5	3.5	6.6	24	8
MINIMUM	6.65	9.05	51.2	47.4	28.7	13.7	644	576
MAXIMUM	16.00	15.65	53.2	50.0	44.3	45.7	701	608

SWB-8

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	FILAMENT GRAND TOTAL	FILAMENT DIAMETER microns	THREAD DIAMETER WARP FILL microns	THREAD COUNT WARP FILL ---per inch---	BREAK STRENGTH WARP lbs.	BREAK STRENGTH FILL lbs.	#1 TGA 50% WT. LOSS °C	#2 TGA °C
AVERAGE	9.63	10.25	38.8	37.7	59.2	56.1	900	809
STD DEV	0.95	1.70	3.2	1.8	15.1	18.1	30	71
MINIMUM	6.90	6.55	33.0	32.8	29.0	22.0	852	652
MAXIMUM	12.45	15.50	44.0	41.2	85.3	87.0	939	881

FABRICS FOR CARBON/CARBON PREPREGS

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WCA

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	FILAMENT GRAND TOTAL	FILAMENT DIAMETER microns	THREAD DIAMETER WARP FILL microns	THREAD COUNT WARP FILL ---per inch---	BREAK STRENGTH WARP lbs.	BREAK STRENGTH FILL lbs.	#1 TGA 50% WT. LOSS °C	#2 TGA °C
AVERAGE	10.59	9.84	29.1	21.9	48.5	19.2	946	870
STD DEV	1.16	1.28	0.3	0.4	10.3	7.0	7	10
MINIMUM	8.00	7.10	29.0	21.0	31.7	8.7	935	855
MAXIMUM	15.55	13.50	30.0	23.0	72.3	33.7	955	888

PWB-6

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	FILAMENT GRAND TOTAL	FILAMENT DIAMETER microns	THREAD DIAMETER WARP FILL microns	THREAD COUNT WARP FILL ---per inch---	BREAK STRENGTH WARP lbs.	BREAK STRENGTH FILL lbs.	#1 TGA 50% WT. LOSS °C	#2 TGA °C
AVERAGE	9.19	9.47	28.3	28.0	26.2	32.9	877	821
STD DEV	0.82	0.88	0.9	1.2	9.8	8.3	18	14
MINIMUM	8.75	9.08	27.4	25.0	4.0	21.3	845	798
MAXIMUM	9.73	9.99	30.8	30.2	48.7	51.0	907	852

COMPARATIVE FABRIC DATA

NAS8-36298

FABRICS FOR CARBON/PHENOLIC PREPREGS

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CCA-3

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GRAND TOTAL	ATOMIC ABSORPTION					125 °C WEIGHT LOSS	600 °C ASH	pH units
	Na	K	Ca	Mg	Li	TOTAL		
-----ppm-----								
AVERAGE	601	38	7	56	0	702	3.958	0.262
STD DEV	207	8	2	15	0	211	2.084	0.129
MINIMUM	318	23	2	32	0	389	1.625	0.070
MAXIMUM	1027	52	12	96	0	1138	7.188	0.794

SWB-8

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GRAND TOTAL	ATOMIC ABSORPTION					125 °C WEIGHT LOSS	600 °C ASH	pH units
	Na	K	Ca	Mg	Li	TOTAL		
-----ppm-----								
AVERAGE	6	1	59	1	0	67	0.012	0.047
STD DEV	2	1	51	1	0	53	0.009	0.044
MINIMUM	3	0	13	0	0	20	0.000	0.005
MAXIMUM	11	2	180	1	0	190	0.029	0.203

FABRICS FOR CARBON/CARBON PREPREGS

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WCA

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GRAND TOTAL	ATOMIC ABSORPTION					125 °C WEIGHT LOSS	600 °C ASH	pH units
	Na	K	Ca	Mg	Li	TOTAL		
-----ppm-----								
AVERAGE	13	0	7	1	0	21	0.016	0.013
STD DEV	2	0	1	1	0	8	0.015	0.007
MINIMUM	4	0	3	0	0	9	0.000	0.000
MAXIMUM	27	1	8	3	0	35	0.060	0.030

PWB-6

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GRAND TOTAL	ATOMIC ABSORPTION					125 °C WEIGHT LOSS	600 °C ASH	pH units
	Na	K	Ca	Mg	Li	TOTAL		
-----ppm-----								
AVERAGE	4	2	83	1	0	90	-0.010	0.057
STD DEV	2	1	25	0	0	24	0.037	0.025
MINIMUM	2	1	38	0	0	46	-0.099	0.020
MAXIMUM	8	3	139	2	0	144	0.045	0.099

CCA-3 FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #11

NAS8-36298

SAMPLE NUMBER				AS RECVD.		4 X 4		INIT. VOLs.	ACETONE PTM-3A	SPECIF. PTM-3A	GRAVITY PTM-84
	CARBON ASSAY	HYDROGEN ASSAY	NITROGEN ASSAY	4 X 4 WEIGHT	DRY WEIGHT	grams	grams				
METHOD	MDQAI	5560		PTM-3A	PTM-3A						
1-1S	97.13	0.123	0.700	2.914	2.729	6.36	-0.40	2.851			
1-1E	97.10	0.140	0.933	2.995	2.814	6.04	-0.18	3.292			
1-2S	97.37	0.143	0.933	2.979	2.815	5.51	-0.45	2.936			
1-2E	97.23	0.137	0.833	2.941	2.797	4.90	-0.39	2.710			
1-3S	97.80	0.127	0.833	2.856	2.697	5.57	-1.29	3.027			
1-3E	97.53	0.143	0.867	3.008	2.834	5.77	-0.63	2.754			
1-4S	97.47	0.123	0.867	2.940	2.787	5.19	-0.31	3.338			
1-4E	97.47	0.113	0.800	2.955	2.813	4.82	-0.25	2.970			
1-5S	97.03	0.117	0.867	2.891	2.775	4.02	-0.01	2.981			
1-5E	96.90	0.127	0.800	2.937	2.814	4.17	0.08	3.252			
1-6S	97.20	0.117	0.700	2.837	2.754	2.92	0.52	2.396			
1-6E	97.23	0.127	0.800	2.958	2.813	4.90	0.11	2.352			
1-7S	97.13	0.133	0.867	2.852	2.795	2.01	0.24	2.757			
1-7E	96.70	0.150	0.800	2.966	2.827	4.67	-0.08	3.539			
2-1S	97.00	0.143	0.867	2.924	2.752	5.86	0.19	3.595			
2-1E	96.73	0.137	0.867	2.952	2.789	5.50	0.49	3.117			
2-2S	96.70	0.140	0.867	2.878	2.730	5.13	0.70	3.939			
2-2E	96.67	0.143	1.000	2.864	2.727	4.78	0.57	2.745			
2-3S	96.67	0.143	0.933	2.925	2.785	4.76	0.29	2.878			
2-3E	96.67	0.143	0.867	2.941	2.794	5.00	0.30	2.948			
2-4S	96.57	0.143	0.900	2.905	2.770	4.64	-0.16	2.805			
2-4E	96.47	0.150	0.900	2.890	2.762	4.44	-0.29	3.360			
2-5S	97.07	0.127	0.800	2.867	2.756	3.87	-0.08	3.460			
2-5E	97.23	0.123	0.733	2.937	2.825	3.81	-0.05	3.390			
2-6S	97.03	0.120	0.833	2.826	2.717	3.85	-0.07	3.655			
2-6E	96.60	0.140	0.767	2.901	2.781	4.14	-0.05	3.213			
3-1S	96.63	0.163	0.733	3.113	2.845	8.60	-0.59	2.962			
3-1E	96.93	0.170	0.833	3.000	2.789	7.02	-1.86	2.639			
3-2S	96.67	0.143	0.800	3.046	2.841	6.74	-2.38	2.993			
3-2E	96.67	0.140	0.900	3.028	2.846	6.03	-3.23	2.564			
3-3S	96.67	0.170	0.867	3.058	2.842	7.04	-2.74	2.238			
3-3E	97.10	0.150	0.967	3.132	2.896	7.54	-1.84	2.730			
3-4S	96.97	0.153	0.900	3.084	2.834	8.12	-0.99	2.613			
3-4E	96.27	0.153	0.800	3.055	2.861	6.35	-0.16	2.698			
3-5S	96.30	0.147	0.833	3.033	2.823	6.93	-0.04	2.774			
3-5E	96.17	0.147	0.833	3.029	2.826	6.72	-0.19	2.977			
3-6S	96.57	0.150	0.867	2.984	2.790	6.51	-0.06	2.600			
3-6E	95.97	0.143	0.767	3.067	2.869	6.44	0.28	2.542			
4-1	96.20	0.147	0.600	3.070	2.862	6.76	-0.01	2.944			
5-1	96.30	0.147	0.800	2.962	2.773	6.40	-0.23	2.424			

CCA-3 GRAND TOTAL				AS RECVD.		4 X 4		INIT. VOLs.	ACETONE PTM-3A	SPECIF. PTM-3A	GRAVITY PTM-84
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	DRY WEIGHT grams	%	%				
AVERAGE	96.85	0.140	0.836	2.962	2.799	5.50	-0.38	2.949			
STD DEV	0.41	0.014	0.077	0.079	0.045	1.39	0.89	0.385			
MINIMUM	95.97	0.113	0.600	2.826	2.697	2.01	-3.23	2.238			
MAXIMUM	97.80	0.170	1.000	3.132	2.896	8.60	0.70	3.939			

CCA-3 FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #12

NAS8-36298

SAMPLE NUMBER	FILAMENT DIAMETER	FILAMENT DIAMETER	THREAD COUNT	THREAD COUNT	BREAK STRENGTH	BREAK STRENGTH	#1 TGA	#2 TGA
	WARP microns	FILL microns	WARP ---per inch---	FILL ---per inch---	WARP 1bs.	FILL 1bs.	50% WT. °C	TEMPERATURE °C
METHOD	S.E.M.	S.E.M.	PTM-5A	PTM-5A	---ASTM D1682---	CTM-51	CTM-51	
1-1S	11.08	10.72	52.4	49.2	34.3	13.7	673	
1-1E			52.0	48.8	37.7	28.0		576
1-2S	10.10		52.0	49.0	35.3	22.0	696	
1-2E			52.8	49.0	35.0	24.3		584
1-3S	10.50		52.2	48.4	32.3	34.0	701	
1-3E			52.4	48.2	32.7	26.0		581
1-4S	10.44		52.0	49.2	32.0	21.7		608
1-4E			51.8	49.6	31.3	29.7		583
1-5S	11.34		52.2	49.6	33.0	23.7	698	
1-5E			52.2	49.4	34.3	20.3		600
1-6S	10.20		52.4	49.4	28.7	24.3	697	
1-6E			52.8	49.2	28.7	25.0		579
1-7S	10.23		52.6	49.0	31.7	29.0	696	
1-7E			51.2	47.4	28.7	23.0		583
2-1S	9.87	10.26	52.0	49.4	32.3	16.7		577
2-1E			51.4	48.8	32.0	23.3		600
2-2S	10.31		52.4	48.8	38.7	15.7		588
2-2E			51.6	48.4	30.7	22.0		589
2-3S	10.13		52.2	49.2	39.7	20.0		603
2-3E			51.6	48.8	34.7	18.7		597
2-4S	10.27		53.0	49.6	31.7	23.0	694	
2-4E			52.4	49.0	30.7	26.0		581
2-5S	10.60		52.4	49.4	35.3	26.3	699	
2-5E			52.8	49.0	37.0	26.0		581
2-6S	10.52		51.8	48.8	37.0	21.3	699	
2-6E			52.4	48.8	33.7	19.3		585
3-1S	10.82	12.73	52.6	49.0	33.3	17.0	647	
3-1E			52.0	48.8	31.0	31.0		593
3-2S	11.08		52.4	49.4	35.0	28.3	647	
3-2E			52.6	49.6	31.0	29.7		590
3-3S	10.76		52.2	49.2	40.3	31.7	644	
3-3E			52.4	49.2	37.7	29.3		585
3-4S	11.14		51.8	49.0	33.7	27.7		587
3-4E			52.6	50.0	37.0	31.7	651	
3-5S	10.48		52.0	49.4	34.3	18.7		585
3-5E			52.8	48.0	44.3	33.0	652	
3-6S	12.38		52.6	49.0	35.3	45.7		588
3-6E			53.2	49.2	38.7	42.3	649	
4-1	10.29	12.35	53.2	48.8	34.3	23.3		586
5-1	12.09	11.58	53.2	49.0	39.3	28.0		592

CCA-3	FILAMENT DIAMETER	FILAMENT DIAMETER	THREAD COUNT	THREAD COUNT	BREAK STRENGTH	BREAK STRENGTH	#1 TGA	#2 TGA
GRAND TOTAL	DIAMETER	DIAMETER	COUNT	COUNT	STRENGTH	STRENGTH	TEMPERATURE	TEMPERATURE
	WARP	FILL	WARP	FILL	WARP	FILL	50% WT.	LOSS
	microns	microns	---per inch---	---per inch---	1bs.	1bs.	°C	°C
AVERAGE	10.69	11.53	52.3	49.0	34.4	25.5	676	588
STD DEV	1.35	1.29	0.5	0.5	3.5	6.6	24	8
MINIMUM	6.65	9.05	51.2	47.4	28.7	13.7	644	576
MAXIMUM	16.00	15.65	53.2	50.0	44.3	45.7	701	608

CCA-3 FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #13

NAS8-36298

SAMPLE NUMBER	ATOMIC ABSORPTION					Li	TOTAL	125 °C WEIGHT	LOSS %	ASH %	600 °C ASH %	pH units
	Na	K	Ca	Mg	ppm							
METHOD			CTM-53B					CTM-53B		CTM-53B	CTM-24B	
1-1S	848	48	5	56	0	957		2.504		0.379		8.45
1-1E	888	52	4	62	0	1006		2.572		0.380		8.35
1-2S	754	41	5	45	0	845		2.862		0.794		8.00
1-2E	652	33	4	72	0	761		2.873		0.273		8.00
1-3S	687	48	5	76	0	816		3.169		0.283		8.45
1-3E	737	44	8	62	0	851		2.813		0.289		7.60
1-4S	584	35	7	83	0	709		3.183		0.209		8.10
1-4E	579	33	6	56	0	674		3.026		0.239		8.25
1-5S	488	33	6	63	0	590		3.012		0.225		8.40
1-5E	512	43	4	54	0	613		3.074		0.233		8.40
1-6S	520	37	8	72	0	637		2.863		0.224		9.30
1-6E	544	34	4	45	0	627		2.946		0.243		9.25
1-7S	726	40	4	33	0	803		3.021		0.312		9.20
1-7E	788	38	7	32	0	865		2.383		0.285		8.70
2-1S	842	45	6	45	0	938		2.272		0.370		8.00
2-1E	1027	50	6	55	0	1138		2.497		0.408		8.20
2-2S	956	45	8	70	0	1079		2.271		0.398		10.00
2-2E	801	37	7	72	0	917		2.104		0.357		9.80
2-3S	844	36	6	50	0	936		2.178		0.351		9.10
2-3E	847	44	6	45	0	942		2.056		0.377		9.05
2-4S	811	43	8	56	0	918		1.925		0.382		8.95
2-4E	833	35	8	45	0	921		1.938		0.328		8.95
2-5S	524	36	8	84	0	652		1.738		0.209		8.45
2-5E	563	45	8	47	0	663		1.701		0.242		8.55
2-6S	423	45	9	61	0	538		1.625		0.276		7.90
2-6E	495	43	8	53	0	599		1.888		0.242		7.80
3-1S	395	40	11	40	0	486		7.188		0.115		7.45
3-1E	357	39	10	58	0	464		6.762		0.095		7.20
3-2S	325	26	5	38	0	394		7.021		0.089		7.70
3-2E	318	30	5	36	0	389		7.001		0.114		7.85
3-3S	325	26	10	96	0	457		6.846		0.135		7.30
3-3E	375	29	9	52	0	465		6.724		0.210		7.15
3-4S	400	24	7	91	0	522		6.811		0.155		8.25
3-4E	382	35	8	40	0	465		6.491		0.234		8.30
3-5S	446	40	2	42	0	530		6.609		0.222		7.60
3-5E	333	34	11	52	0	430		6.618		0.109		7.55
3-6S	395	23	12	60	0	490		6.741		0.105		6.00
3-6E	362	23	2	45	0	432		6.428		0.070		7.50
4-1	820	50	6	52	0	928		6.298		0.312		7.70
5-1	538	42	9	60	0	649		6.291		0.195		6.90

CCA-3 GRAND TOTAL	ATOMIC ABSORPTION					Li	TOTAL	125 °C WEIGHT	LOSS %	ASH %	600 °C ASH %	pH units
	Na	K	Ca	Mg	ppm							
AVERAGE	601	38	7	56	0	702		3.958		0.262		8.19
STD DEV	207	8	2	15	0	211		2.084		0.129		0.80
MINIMUM	318	23	2	32	0	389		1.625		0.070		6.00
MAXIMUM	1027	52	12	96	0	1138		7.188		0.794		10.00

CCA-3 FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

Page #14

NAS8-36298

LOT	CARBON			HYDROGEN			NITROGEN			AS RECVD. 4 X 4		INIT.	ACETONE VOLS.	SPECIF. CHANGE	GRAVITY
	AVERAGE	ASSAY	%	ASSAY	%	ASSAY	%	4 X 4	DRY WEIGHT	WEIGHT	grams	grams	%	%	units
LOT #1	97.24	0.130	0.829	2.931	2.790	4.78	-0.22	2.940							
LOT #2	96.78	0.138	0.861	2.901	2.766	4.65	0.15	3.259							
LOT #3	96.58	0.153	0.842	3.052	2.838	7.00	-1.15	2.694							
LOT #4	96.20	0.147	0.600	3.070	2.862	6.76	-0.01	2.944							
LOT #5	96.30	0.147	0.800	2.962	2.773	6.40	-0.23	2.424							
AVERAGE	96.85	0.140	0.836	2.962	2.799	5.50	-0.38	2.949							
STD DEV	0.41	0.014	0.077	0.079	0.045	1.39	0.89	0.385							
COUNT	40	40	40	40	40	40	40	40							
<u>A BASIS</u>															
FACTOR	2.941	2.941	2.941	2.941	2.941	2.941	2.941	2.941							
MINIMUM	95.63	0.100	0.609	2.731	2.666	1.42	-2.99	1.817							
MAXIMUM	98.07	0.180	1.063	3.194	2.931	9.58	2.23	4.081							

LOT	FILAMENT		FILAMENT		THREAD		THREAD		BREAK		BREAK		#1 TGA	#2 TGA	TEMPERATURE
	DIAMETER	WARP	DIAMETER	FILL	COUNT	WARP	COUNT	STRENGTH	WARP	STRENGTH	FILL	50% WT.	LOSS	'C	'C
AVERAGE															
	microns	microns		--per inch--					lbs.	lbs.					
LOT #1	10.55	10.72	10.26	52.2	49.0	49.0	49.2	32.5	24.6	21.5	30.5	694	697	589	
LOT #2	10.28	12.73	12.35	52.4	53.2	53.2	53.7	34.4	36.0	34.3	34.3	648	648	588	
LOT #3	11.11	11.58	11.29	52.2	49.0	48.8	49.0	36.0	30.5	23.3	28.0	694	676	588	
LOT #4	10.29	12.73	12.35	52.4	49.2	48.8	49.0	34.3	24.2	6.2	44.6	590	762	562	
LOT #5	12.09	11.58	11.29	53.2	49.0	49.0	49.0	39.3	28.0	44.8	44.8	762	762	614	
AVERAGE	10.69	11.53	11.29	52.3	49.0	49.0	49.0	34.4	25.5	25.5	25.5	676	676	588	
STD DEV	1.35	1.29	1.29	0.5	0.5	0.5	0.5	3.5	6.6	6.6	40	24	15	8	
COUNT	21	5	40	40	40	40	40	40	40	40	40				
<u>A BASIS</u>															
FACTOR	3.263	5.741	2.941	2.941	2.941	2.941	2.941	2.941	2.941	2.941	2.941	3.520	3.520	3.158	
MINIMUM	6.28	4.13	50.9	47.6	47.6	47.6	47.6	24.2	6.2	6.2	44.6	590	762	562	
MAXIMUM	15.11	18.93	53.7	50.4	50.4	50.4	50.4	44.6	44.8	44.8	44.8	762	762	614	

LOT	ATOMIC ABSORPTION					125 °C		600 °C	ASH	pH
	Na	K	Ca	Mg	L1	TOTAL	WEIGHT	%	%	units
	ppm-----									
LOT #1	665	40	6	58	0	768	2.879	0.312	8.46	
LOT #2	747	42	7	57	0	853	2.016	0.328	8.73	
LOT #3	368	31	8	54	0	460	6.770	0.138	7.49	
LOT #4	820	50	6	52	0	928	6.298	0.312	7.70	
LOT #5	538	42	9	60	0	649	6.291	0.195	6.90	
AVERAGE	601	38	7	56	0	702	3.958	0.262	8.19	
STD DEV	207	8	2	15	0	211	2.084	0.129	0.80	
COUNT	40	40	40	40	40	40	40	40	40	
<u>A BASIS</u>										
FACTOR	2.941	2.941	2.941	2.941	2.941	2.941	2.941	2.941	2.941	2.941
MINIMUM	-8	16	0	11	0	81	-2.172	-0.119	5.83	
MAXIMUM	1210	61	14	102	0	1324	10.088	0.642	10.55	

SWB-8 FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #15

NAS8-36298

SAMPLE NUMBER	AS RECVD.			4 X 4		INIT. VOLS.	ACETONE SPECIF.		
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	DRY WEIGHT grams		%	%	CHANGE units
METHOD -----MDQAI 5560-----				PTM-3A	PTM-3A	PTM-3A	PTM-3A	PTM-84	
1-1	99.57	0.014	0.001	2.799	2.788	0.39	-0.14	1.800	
2-1	99.27	0.027	0.173	3.326	3.312	0.41	-0.09	1.807	
2-2	99.43	0.017	0.170	3.583	3.568	0.41	0.03	2.040	
2-3	99.77	0.010	0.120	3.262	3.245	0.51	-0.06	2.041	
2-4	99.60	0.013	0.100	3.592	3.577	0.43	-0.09	2.171	
2-5	99.30	0.004	0.073	3.657	3.641	0.44	-0.08	2.380	
2-6	99.80	0.017	0.100	3.402	3.389	0.38	-0.10	2.164	
2-7	99.63	0.001	0.080	3.694	3.679	0.40	-0.08	2.065	
2-8	99.77	0.001	0.167	3.098	3.084	0.47	-0.11	2.191	
2-9	99.80	0.001	0.200	3.121	3.109	0.38	-0.26	1.782	
2-10	99.57	0.004	0.167	3.150	3.136	0.43	-0.09	1.733	
2-11	99.60	0.004	0.100	3.434	3.421	0.37	-0.15	1.780	
2-12	99.60	0.007	0.133	3.242	3.227	0.45	-0.21	1.632	
2-13	99.90	0.001	0.073	3.018	3.005	0.43	-0.21	1.694	
3-1	99.90	0.001	0.100	2.934	2.923	0.35	-0.22	1.728	
4-1	99.87	0.001	0.070	3.060	3.049	0.38	-0.28	1.660	
4-2	99.57	0.004	0.200	2.969	2.957	0.42	-0.32	1.686	
5-1	99.47	0.004	0.133	3.376	3.363	0.37	-0.24	1.692	

SWB-8 GRAND TOTAL	AS RECVD.			4 X 4		INIT. VOLS.	ACETONE SPECIF.		
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	DRY WEIGHT grams		%	%	CHANGE units
AVERAGE	99.63	0.007	0.120	3.262	3.249	0.41	-0.15	1.892	
STD DEV	0.19	0.007	0.053	0.264	0.263	0.04	0.09	0.229	
MINIMUM	99.27	0.001	0.001	2.799	2.788	0.35	-0.32	1.632	
MAXIMUM	99.90	0.027	0.200	3.694	3.679	0.51	0.03	2.380	

SWB-8 FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGE	AS RECVD.			4 X 4		INIT. VOLS.	ACETONE SPECIF.		
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	DRY WEIGHT grams		%	%	CHANGE units
LOT #1	99.57	0.014	0.001	2.799	2.788	0.39	-0.14	1.800	
LOT #2	99.62	0.008	0.127	3.352	3.338	0.42	-0.12	1.960	
LOT #3	99.90	0.001	0.100	2.934	2.923	0.35	-0.22	1.728	
LOT #4	99.72	0.003	0.135	3.015	3.003	0.40	-0.30	1.673	
LOT #5	99.47	0.004	0.133	3.376	3.363	0.37	-0.24	1.692	
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
AVERAGE	99.63	0.007	0.120	3.262	3.249	0.41	-0.15	1.892	
STD DEV	0.19	0.007	0.053	0.264	0.263	0.04	0.09	0.229	
COUNT	18	18	18	18	18	18	18	18	18
<u>A BASIS</u>									
FACTOR	3.370	3.370	3.370	3.370	3.370	3.370	3.370	3.370	3.370
MINIMUM	98.99	-0.018	-0.057	2.371	2.361	0.28	-0.46	1.121	
MAXIMUM	100.28	0.032	0.297	4.153	4.136	0.55	0.16	2.662	

SWB-8 FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #16

NAS8-36298

SAMPLE NUMBER	FILAMENT DIAMETER		FILAMENT DIAMETER		THREAD COUNT		THREAD COUNT		BREAK STRENGTH	BREAK STRENGTH	#1 TGA	#2 TGA
	WARP microns	FILL microns	WARP microns	FILL microns	---per inch---	1bs.	WARP	FILL	50% WT. LOSS °C	°C	CTM-51	CTM-51
METHOD S.E.M.	S.E.M.	PTM-5A	PTM-5A	---ASTM D1682---	---							
1-1	9.86	9.99	36.4	32.8	55.7	49.3	49.3	903				
2-1	9.12	10.00	40.8	38.0	63.7	74.0					867	
2-2	9.60		44.0	38.0	48.7	63.3					881	
2-3	9.64		40.2	35.6	72.3	71.0						
2-4	9.58		43.6	38.6	53.7	74.7					926	
2-5	10.03		42.6	38.2	62.7	50.7					934	
2-6	9.36		40.0	37.4	64.7	60.0					834	
2-7	9.65		38.6	38.8	74.3	59.0					825	
2-8	9.28		35.8	38.6	29.0	22.0					825	
2-9	9.74		40.6	37.4	42.0	51.3					879	
2-10	9.85		35.2	38.4	39.3	50.3					833	
2-11	9.55		39.4	41.2	64.7	83.7					782	
2-12	9.18		41.2	39.0	85.3	58.7						
2-13	10.11		34.4	38.8	43.3	50.3					905	
3-1	9.79	10.83	35.0	36.8	77.0	26.7					794	
4-1	9.55	10.03	37.4	38.6	71.3	46.7					869	
4-2	9.34		33.0	35.2	70.3	31.0					652	
5-1	10.17	10.43	39.6	36.4	48.0	87.0					852	

GRAND TOTAL	FILAMENT DIAMETER		FILAMENT DIAMETER		THREAD COUNT		THREAD COUNT		BREAK STRENGTH	BREAK STRENGTH	#1 TGA	#2 TGA
	WARP microns	FILL microns	WARP microns	FILL microns	---per inch---	1bs.	WARP	FILL	50% WT. LOSS °C	°C	CTM-51	CTM-51
AVERAGE	9.63	10.25	38.8	37.7	59.2	56.1	56.1	900			809	
STD DEV	0.95	1.70	3.2	1.8	15.1	18.1	18.1	30			71	
MINIMUM	6.90	6.55	33.0	32.8	29.0	22.0	22.0	852			652	
MAXIMUM	12.45	15.50	44.0	41.2	85.3	87.0	87.0	939			881	

SWB-8 FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGE	FILAMENT DIAMETER		FILAMENT DIAMETER		THREAD COUNT		THREAD COUNT		BREAK STRENGTH	BREAK STRENGTH	#1 TGA	#2 TGA
	WARP microns	FILL microns	WARP microns	FILL microns	---per inch---	1bs.	WARP	FILL	50% WT. LOSS °C	°C	CTM-51	CTM-51
LOT #1	9.86	9.99	36.4	32.8	55.7	49.3	49.3	903				
LOT #2	9.59	10.00	39.7	38.3	57.2	59.2	59.2	910			837	
LOT #3	9.79	10.83	35.0	36.8	77.0	26.7	26.7				794	
LOT #4	9.44	10.03	35.2	36.9	70.8	38.8	38.8	869			652	
LOT #5	10.17	10.43	39.6	36.4	48.0	87.0	87.0	852				

AVERAGE	FILAMENT DIAMETER		FILAMENT DIAMETER		THREAD COUNT		THREAD COUNT		BREAK STRENGTH	BREAK STRENGTH	#1 TGA	#2 TGA
	WARP microns	FILL microns	WARP microns	FILL microns	---per inch---	1bs.	WARP	FILL	50% WT. LOSS °C	°C	CTM-51	CTM-51
COUNT	18	5	18	18							10	8
FACTOR	3.370	5.741	3.370	3.370	3.370	3.370	3.370	3.981	4.354			
MINIMUM	6.42	0.50	27.8	31.5	8.2	-5.1	782				498	
MAXIMUM	12.84	20.01	49.7	43.8	110.3	117.2	1017				1119	

SWB-8 FABRIC TEST DATA
AVERAGE TEST RESULTS

NAS8-36298

SAMPLE NUMBER	ATOMIC ABSORPTION					125 °C WEIGHT	600 °C LOSS %	ASH %	pH units
	Na	K	Ca	Mg	Li TOTAL				
-----ppm-----									
METHOD	CTM-53B					CTM-53B	CTM-53B	CTM-24B	
1-1	7	0	90	0	0	97	0.029	0.059	7.40
2-1	3	1	31	0	0	35	0.020	0.020	6.45
2-2	4	1	32	0	0	37	0.025	0.035	4.20
2-3	6	1	16	1	0	24	0.020	0.020	6.15
2-4	3	2	25	0	0	30	0.015	0.020	6.15
2-5	5	2	16	1	0	24	0.005	0.010	6.20
2-6	6	1	13	1	0	21	0.015	0.035	6.40
2-7	4	1	15	0	0	20	0.005	0.030	6.00
2-8	9	1	77	1	0	88	0.000	0.080	6.40
2-9	11	1	101	1	0	114	0.010	0.059	6.95
2-10	7	1	62	0	0	70	0.015	0.070	6.20
2-11	6	1	54	0	0	61	0.010	0.055	6.55
2-12	4	1	29	0	0	34	0.005	0.005	6.00
2-13	4	1	30	1	0	36	0.005	0.029	6.85
3-1	7	2	146	0	0	155	0.000	0.030	9.00
4-1	5	2	17	1	0	25	0.010	0.025	6.30
4-2	8	1	180	1	0	190	0.025	0.203	8.40
5-1	11	1	130	1	0	143	0.000	0.065	6.25

SWB-8 GRAND TOTAL	ATOMIC ABSORPTION					125 °C WEIGHT	600 °C		
	Na	K	Ca	Mg	Li TOTAL	LOSS %	ASH %		pH units
	-----ppm-----								
AVERAGE	6	1	59	1	0	67	0.012	0.047	6.55
STD DEV	2	1	51	1	0	53	0.009	0.044	1.01
MINIMUM	3	0	13	0	0	20	0.000	0.005	4.20
MAXIMUM	11	2	180	1	0	190	0.029	0.203	9.00

SWB-8 FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGE	ATOMIC ABSORPTION					125 °C WEIGHT	600 °C LOSS %	ASH %	pH units
	Na	K	Ca	Mg	Li TOTAL				
-----ppm-----									
LOT #1	7	0	90	0	0	97	0.029	0.059	7.40
LOT #2	6	1	39	0	0	46	0.011	0.036	6.19
LOT #3	7	2	146	0	0	155	0.000	0.030	9.00
LOT #4	7	2	99	1	0	108	0.017	0.114	7.35
LOT #5	11	1	130	1	0	143	0.000	0.065	6.25
=====									
AVERAGE	6	1	59	1	0	67	0.012	0.047	6.55
STD DEV	2	1	51	1	0	53	0.009	0.044	1.01
COUNT	18	18	18	18	18	18	18	18	18
<u>A BASIS</u>									
FACTOR	3.370	3.370	3.370	3.370	3.370	3.370	3.370	3.370	3.370
MINIMUM	-2	-1	-113	-1	0	-111	-0.019	-0.103	3.15
MAXIMUM	14	3	231	2	0	245	0.043	0.197	9.95

WCA FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #18

NAS8-36298

SAMPLE NUMBER				AS RECVD.		4 X 4		INIT. VOLS.	ACETONE CHANGE	SPECIF. GRAVITY
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	DRY WEIGHT grams	PTM-3A	PTM-3A			
METHOD	MDQAI 5560			PTM-3A	PTM-3A					
1-1S	99.53	0.004	0.123	2.555	2.545	0.38	0.21	1.617		
1-1E	99.87	0.001	0.077	2.544	2.533	0.43	0.24	1.666		
1-2S	99.83	0.001	0.133	2.512	2.498	0.53	0.28	1.631		
1-2E	99.73	0.001	0.100	2.562	2.549	0.51	0.29	1.719		
2-1S	99.60	0.023	0.100	2.444	2.434	0.40	0.14	1.622		
2-1E	99.47	0.017	0.167	2.532	2.524	0.33	0.07	1.669		
2-2S	99.73	0.013	0.100	2.479	2.471	0.34	0.01	1.637		
2-2E	99.60	0.007	0.137	2.452	2.445	0.30	0.01	1.640		
2-3S	99.57	0.001	0.043	2.554	2.547	0.27	0.00	1.634		
2-3E	99.57	0.007	0.040	2.471	2.464	0.28	0.00	1.610		
3-1S	99.57	0.004	0.083	2.486	2.479	0.28	0.01	1.663		
3-1E	99.67	0.007	0.037	2.494	2.484	0.39	0.01	1.634		
4-1S	99.40	0.004	0.333	2.441	2.430	0.45	0.00	1.611		
4-1E	99.67	0.007	0.167	2.602	2.589	0.50	-0.06	1.643		
4-2S	99.67	0.001	0.100	2.579	2.565	0.54	-0.04	1.639		
4-2E	99.43	0.001	0.110	2.567	2.552	0.58	-0.11	1.618		
5-1	99.67	0.001	0.133	2.558	2.543	0.60	-0.04	1.687		

WCA GRAND TOTAL				AS RECVD.		4 X 4		INIT. VOLS.	ACETONE CHANGE	SPECIF. GRAVITY
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	DRY WEIGHT grams	PTM-3A	PTM-3A			
AVERAGE	99.62	0.006	0.117	2.520	2.509	0.42	0.06	1.644		
STD DEV	0.13	0.006	0.068	0.051	0.049	0.11	0.12	0.029		
MINIMUM	99.40	0.001	0.037	2.441	2.430	0.27	-0.11	1.610		
MAXIMUM	99.87	0.023	0.333	2.602	2.589	0.60	0.29	1.719		

WCA FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGE				AS RECVD.		4 X 4		INIT. VOLS.	ACETONE CHANGE	SPECIF. GRAVITY
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	DRY WEIGHT grams	PTM-3A	PTM-3A			
LOT #1H	99.74	0.002	0.111	2.537	2.525	0.45	0.24	1.638		
LOT #2H	99.53	0.020	0.133	2.488	2.479	0.36	0.10	1.646		
LOT #4H	99.53	0.006	0.250	2.522	2.510	0.47	-0.03	1.627		
LOT #2K	99.62	0.007	0.080	2.489	2.482	0.30	0.01	1.630		
LOT #4K	99.55	0.001	0.105	2.573	2.559	0.56	-0.07	1.628		
AVERAGE	99.62	0.006	0.117	2.520	2.509	0.42	0.06	1.644		
STD DEV	0.13	0.006	0.068	0.051	0.049	0.11	0.12	0.029		
COUNT	17	17	17	17	17	17	17	17		
<u>A BASIS</u>										
FACTOR	3.414	3.414	3.414	3.414	3.414	3.414	3.414	3.414		
MINIMUM	99.18	-0.016	-0.116	2.346	2.341	0.04	-0.36	1.544		
MAXIMUM	100.06	0.028	0.350	2.693	2.677	0.79	0.48	1.743		

WCA FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #19

NAS8-36298

SAMPLE NUMBER	FILAMENT	FILAMENT	THREAD	THREAD	BREAK	BREAK	#1 TGA	#2 TGA	TEMPERATURE @
	DIAMETER	DIAMETER	COUNT	COUNT	STRENGTH	STRENGTH	50% WT.	LOSS	
	WARP	FILL	WARP	FILL	WARP	FILL	'C	'C	
METHOD	S.E.M.	S.E.M.	PTM-5A	PTM-5A	---ASTM D1682---	CTM-51	CTM-51	CTM-51	
1-1S	10.88	10.07	30.0	23.0	55.3	14.3	935		855
1-1E	11.54		29.0	22.0	42.3	9.3			
1-2S	11.77		29.0	22.0	43.3	13.7	936		859
1-2E	11.72		29.0	22.0	72.3	23.3			
2-1S	10.28	10.48	29.2	22.0	54.3	33.7	943		868
2-1E	10.63		29.0	22.0	49.3	19.0			
2-2S	10.92		29.2	21.0	51.0	23.7	944		876
2-2E	10.15		29.0	22.0	61.0	23.0			
2-3S	10.72		29.4	22.0	45.7	23.7	950		876
2-3E	10.27		29.0	21.0	52.3	19.3			
3-1S	9.33	9.36	29.0	22.0	52.3	18.0	951		
3-1E	10.19		29.0	22.0	46.7	24.3	949		
4-1S	10.46	9.21	29.0	22.0	55.7	29.0			868
4-1E	10.12		29.0	22.0	31.7	10.0	954		
4-2S	10.67		29.0	22.0	33.3	12.7			
4-2E	10.18		29.0	22.0	43.7	20.0	955		
5-1	10.30	10.11	29.0	22.0	34.3	8.7			888

WCA	FILAMENT	FILAMENT	THREAD	THREAD	BREAK	BREAK	#1 TGA	#2 TGA	TEMPERATURE @
GRAND	DIAMETER	DIAMETER	COUNT	COUNT	STRENGTH	STRENGTH	50% WT.	LOSS	
TOTAL	WARP	FILL	WARP	FILL	WARP	FILL	'C	'C	
	microns	microns	---per inch---		lbs.	lbs.			
AVERAGE	10.59	9.84	29.1	21.9	48.5	19.2	946	870	
STD DEV	1.16	1.28	0.3	0.4	10.3	7.0	7	10	
MINIMUM	8.00	7.10	29.0	21.0	31.7	8.7	935	855	
MAXIMUM	15.55	13.50	30.0	23.0	72.3	33.7	955	888	

WCA FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT	FILAMENT	FILAMENT	THREAD	THREAD	BREAK	BREAK	#1 TGA	#2 TGA	TEMPERATURE @
	DIAMETER	DIAMETER	COUNT	COUNT	STRENGTH	STRENGTH	50% WT.	LOSS	
	AVERAGE	WARP	FILL	WARP	FILL	WARP	FILL	'C	'C
	microns	microns	---per inch---		lbs.	lbs.			
LOT #1H	11.40	10.07	29.3	22.3	47.0	12.4	936	855	
LOT #2H	10.45	10.48	29.1	22.0	51.8	26.3	943	868	
LOT #4H	10.29	9.21	29.0	22.0	43.7	19.5	954	868	
LOT #2K	10.51	--	29.2	21.5	52.5	22.4	947	876	
LOT #4K	10.42	--	29.0	22.0	38.5	16.3	955	868	
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
AVERAGE	10.59	9.84	29.1	21.9	48.5	19.2	946	870	
STD DEV	1.16	1.28	0.3	0.4	10.3	7.0	7	10	
COUNT		5	17	17	17	17	17	9	8
<u>A BASIS</u>									
FACTOR	3.414	5.741	3.414	3.414	3.414	3.414	4.143	4.354	
MINIMUM	6.64	2.49	28.2	20.5	13.3	-4.9	916	825	
MAXIMUM	14.55	17.19	30.0	23.4	83.8	43.2	977	915	

WCA FABRIC TEST DATA
AVERAGE TEST RESULTS

Page #20

NAS8-36298

SAMPLE NUMBER	ATOMIC ABSORPTION					Li	TOTAL	125 °C WEIGHT	600 °C LOSS	ASH	pH units
	Na	K	Ca	Mg	ppm						
----- METHOD ----- CTM-53B-----											
1-1S	18	1	8	1	0	28		0.025	0.010	6.50	
1-1E	23	0	8	0	0	31		0.015	0.020	6.35	
1-2S	6	0	7	1	0	14		0.010	0.020	6.60	
1-2E	25	1	7	1	0	34		0.035	0.010	6.50	
2-1S	27	0	8	0	0	35		0.025	0.010	6.30	
2-1E	19	0	8	0	0	27		0.015	0.030	6.75	
2-2S	5	1	7	1	0	14		0.015	0.000	6.35	
2-2E	12	0	8	1	0	21		0.005	0.015	6.50	
2-3S	11	0	7	0	0	18		0.060	0.015	6.40	
2-3E	15	1	7	0	0	23		0.010	0.020	6.35	
3-1S	10	0	6	2	0	18		0.000	0.005	6.40	
3-1E	9	0	6	3	0	18		0.030	0.015	6.40	
4-1S	10	0	6	3	0	19		0.000	0.010	6.30	
4-1E	9	0	5	2	0	16		0.015	0.010	6.40	
4-2S	5	0	4	3	0	12		0.005	0.010	6.20	
4-2E	6	0	6	2	0	14		0.005	0.010	6.35	
5-1	4	0	3	2	0	9		0.005	0.010	6.40	
----- WCA GRAND TOTAL ----- ppm-----											
AVERAGE	13	0	7	1	0	21		0.016	0.013	6.41	
STD DEV	2	0	1	1	0	8		0.015	0.007	0.13	
MINIMUM	4	0	3	0	0	9		0.000	0.000	6.20	
MAXIMUM	27	1	8	3	0	35		0.060	0.030	6.75	

WCA FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGE	ATOMIC ABSORPTION					Li	TOTAL	125 °C WEIGHT	600 °C LOSS	ASH	pH units
	Na	K	Ca	Mg	ppm						
----- LOT #1H ----- ppm-----											
LOT #1H	16	0	8	1	0	24		0.017	0.017	6.48	
LOT #2H	23	0	8	0	0	31		0.020	0.020	6.53	
LOT #4H	10	0	6	3	0	18		0.007	0.010	6.35	
LOT #2K	11	1	7	1	0	19		0.023	0.012	6.40	
LOT #4K	6	0	5	3	0	13		0.005	0.010	6.28	
===== AVERAGE ----- STD DEV ----- COUNT ----- A BASIS ----- FACTOR ----- MINIMUM ----- MAXIMUM -----											
AVERAGE	13	0	7	1	0	21		0.016	0.013	6.41	
STD DEV	2	0	1	1	0	8		0.015	0.007	0.13	
COUNT	17	17	17	17	17	17	17		17	17	
A BASIS	3.414	3.414	3.414	3.414	3.414	3.414	3.414	3.414	3.414	3.414	3.414
FACTOR	-	-	-	-	-	-	-	-	-	-	5.98
MINIMUM	6	-1	1.54	-2	0	-6.1	-0.036	-0.011	-	-	6.85
MAXIMUM	19	2	11.5	5	0	47.4	0.068	0.036	-	-	

PWB-6 FABRIC TEST DATA
AVERAGE TEST RESULTS

NAS8-36298

SAMPLE NUMBER	AS RECVD.			4 X 4		DRY WEIGHT grams	INIT. VOLS.	ACETONE CHANGE	SPECIF. GRAVITY
	CARBON ASSAY %	HYDROGEN ASSAY %	NITROGEN ASSAY %	4 X 4 WEIGHT grams	PTM-3A				
METHOD	-----MDQAI 5560-----				PTM-3A	PTM-3A	PTM-3A	PTM-3A	PTM-84
1-1	99.83	0.004	0.133	2.310	2.303	0.30	0.01	1.832	
2-14	99.80	0.010	0.103	2.404	2.389	0.62	-0.01	1.817	
3-1	99.83	0.004	0.070	2.524	2.511	0.53	-0.03	1.750	
3-2	99.90	0.007	0.100	3.017	3.002	0.52	-0.01	1.857	
4-1	99.90	0.004	0.100	2.575	2.559	0.61	-0.09	1.831	
4-2	99.80	0.004	0.010	2.194	2.176	0.79	-0.09	1.806	
4-3	99.83	0.004	0.133	2.447	2.428	0.76	-0.11	1.761	
4-4	99.90	0.007	0.100	2.438	2.419	0.78	-0.16	1.779	
4-5	99.90	0.004	0.100	2.504	2.486	0.75	-0.21	1.832	
4-6	99.87	0.007	0.100	2.299	2.280	0.83	-0.29	1.835	
4-7	99.83	0.001	0.100	2.242	2.234	0.34	-0.08	1.834	
4-8	99.83	0.001	0.100	2.334	2.322	0.49	0.07	1.787	
4-9	99.90	0.004	0.100	2.300	2.289	0.48	0.04	1.789	
4-10	99.77	0.001	0.073	2.514	2.501	0.54	0.05	1.790	
4-11	99.90	0.010	0.040	2.406	2.391	0.62	0.06	1.809	
4-12	99.90	0.007	0.040	2.414	2.398	0.68	-0.03	1.802	
4-13	99.83	0.017	0.133	2.577	2.562	0.60	-0.04	1.840	
5-1	99.80	0.001	0.103	2.334	2.320	0.60	-0.01	1.835	
5-2	99.90	0.004	0.100	2.247	2.232	0.65	-0.15	1.805	
2R-1	99.87	0.017	0.010	2.580	2.570	0.37	0.03	1.783	
<hr/>									
PWB-6					AS RECVD.	4 X 4			
GRAND TOTAL	CARBON ASSAY	HYDROGEN ASSAY	NITROGEN ASSAY	4 X 4 WEIGHT	DRY WEIGHT grams	INIT. VOLS.	ACETONE CHANGE	SPECIF. GRAVITY	
	%	%	%	grams	grams	%	%	units	
AVERAGE	99.86	0.006	0.088	2.433	2.419	0.59	-0.05	1.809	
STD DEV	0.04	0.005	0.036	0.181	0.181	0.15	0.10	0.028	
MINIMUM	99.77	0.001	0.010	2.194	2.176	0.30	-0.29	1.750	
MAXIMUM	99.90	0.017	0.133	3.017	3.002	0.83	0.07	1.857	

PWB-6 FABRIC TEST DATA
AVERAGE TEST RESULTS

NAS8-36298

SAMPLE NUMBER	FILAMENT DIAMETER WARP microns	FILAMENT DIAMETER FILL microns	THREAD COUNT WARP ---per inch---	THREAD COUNT FILL ---per inch---	BREAK STRENGTH WARP lbs.	BREAK STRENGTH FILL lbs.	#1 TGA 50% WT. LOSS °C	#2 TGA °C
METHOD	S.E. M.	S.E. M.	PTM-5A	PTM-5A	ASTM D1682---	CTM-51	CTM-51	
1-1	9.25	9.91	28.6	25.0	48.7	46.3	873	
2-14	9.14		28.0	29.2	25.0	40.3		828
3-1	8.93	9.08	30.8	28.4	32.7	25.3	907	
3-2	9.48		29.4	30.2	26.3	26.3		809
4-1	8.75	9.10	29.2	28.2	31.0	27.0	876	
4-2	9.59		27.8	27.6	24.7	36.3		815
4-3	9.47		28.4	28.6	25.0	25.3	886	
4-4	9.40		27.4	27.8	27.7	34.7		828
4-5	8.79		29.4	28.0	29.0	22.3	878	
4-6	9.15		27.4	27.0	23.0	21.3		828
4-7	9.26		27.6	27.0	34.0	27.3	856	
4-8	9.14		27.8	28.0	35.7	25.7		816
4-9	9.03		28.2	28.0	25.0	33.3	876	
4-10	9.10		28.0	28.6	28.0	34.3		819
4-11	9.06		27.4	27.8	19.3	33.0	845	
4-12	9.28		27.4	27.6	20.3	46.0		798
4-13	9.04		28.6	29.4	4.0	38.0	874	
5-1	8.90	9.31	28.6	26.4	29.7	31.7	900	
5-2	9.42		28.6	26.6	30.0	32.0		852
2R-1	9.73	9.99	27.8	30.0	4.7	51.0		820

PWB-6 GRAND TOTAL	FILAMENT DIAMETER WARP microns	FILAMENT DIAMETER FILL microns	THREAD COUNT WARP ---per inch---	THREAD COUNT FILL ---per inch---	BREAK STRENGTH WARP lbs.	BREAK STRENGTH FILL lbs.	#1 TGA 50% WT. LOSS °C	#2 TGA °C
AVERAGE	9.19	9.47	28.3	28.0	26.2	32.9	877	821
STD DEV	0.82	0.88	0.9	1.2	9.8	8.3	18	14
MINIMUM	8.75	9.08	27.4	25.0	4.0	21.3	845	798
MAXIMUM	9.73	9.99	30.8	30.2	48.7	51.0	907	852

PWB-6 FABRIC TEST DATA
AVERAGE TEST RESULTS

NAS8-36298

SAMPLE NUMBER	ATOMIC ABSORPTION					125 °C WEIGHT	600 °C ASH	pH units
	Na	K	Ca	Mg	Li TOTAL			
METHOD	-----ppm-----							CTM-53B
1-1	8	3	95	2	0	108	0.005	0.087 9.30
2-14	2	1	104	1	0	108	-0.099	0.099 8.75
3-1	6	1	95	1	0	103	0.034	0.075 9.35
3-2	3	1	139	1	0	144	0.010	0.097 8.40
4-1	3	2	69	1	0	75	-0.044	0.039 7.55
4-2	5	2	80	1	0	88	-0.015	0.029 7.45
4-3	2	2	64	1	0	69	-0.015	0.020 7.80
4-4	4	3	55	0	0	62	-0.029	0.059 7.80
4-5	6	3	61	1	0	71	0.015	0.040 7.85
4-6	4	2	88	0	0	94	-0.005	0.062 7.75
4-7	2	2	92	0	0	96	-0.099	0.025 7.80
4-8	4	2	105	1	0	112	-0.025	0.080 7.90
4-9	2	2	80	1	0	85	0.010	0.041 7.60
4-10	2	2	89	1	0	94	-0.010	0.067 7.60
4-11	3	1	100	1	0	105	0.010	0.054 10.00
4-12	4	1	117	1	0	123	0.015	0.068 10.10
4-13	4	2	77	1	0	84	-0.005	0.063 10.05
5-1	4	3	38	1	0	46	0.005	0.025 8.40
5-2	5	2	38	1	0	46	-0.005	0.025 7.90
2R-1	4	2	81	1	0	88	0.045	0.078 9.35
<hr/>								
PWB-6 GRAND TOTAL	ATOMIC ABSORPTION					125 °C WEIGHT	600 °C ASH	pH units
	Na	K	Ca	Mg	Li TOTAL	LOSS	ASH	

AVERAGE	4	2	83	1	0	90	-0.010	0.057 8.44
STD DEV	2	1	25	0	0	24	0.037	0.025 0.92
MINIMUM	2	1	38	0	0	46	-0.099	0.020 7.45
MAXIMUM	8	3	139	2	0	144	0.045	0.099 10.10

PWB-6 FABRIC
LOT AVERAGES AND STATISTICAL SUMMARY

Page #24

NAS8-36298

AS RECVD. 4 X 4

LOT	CARBON	HYDROGEN	NITROGEN	4 X 4	DRY	INIT.	ACETONE	SPECIF.
AVERAGE	ASSAY	ASSAY	ASSAY	WEIGHT	WEIGHT	VOLS.	CHANGE	GRAVITY
	%	%	%	grams	grams	%	%	units
LOT #1	99.83	0.004	0.133	2.310	2.303	0.30	0.01	1.832
LOT #2	99.80	0.010	0.103	2.404	2.389	0.62	-0.01	1.817
LOT #3	99.87	0.006	0.085	2.771	2.756	0.52	-0.02	1.804
LOT #4	99.86	0.006	0.087	2.403	2.388	0.64	-0.07	1.807
LOT #5	99.85	0.003	0.102	2.291	2.276	0.63	-0.08	1.820
LOT #2R	99.87	0.017	0.010	2.580	2.570	0.37	0.03	1.783
AVERAGE	99.86	0.006	0.088	2.433	2.419	0.59	-0.05	1.809
STD DEV	0.04	0.005	0.036	0.181	0.181	0.15	0.10	0.028
COUNT	20	20	20	20	20	20	20	20
A BASIS								
FACTOR	3.295	3.295	3.295	3.295	3.295	3.295	3.295	3.295
MINIMUM	99.71	-0.009	-0.033	1.836	1.823	0.10	-0.37	1.715
MAXIMUM	100.00	0.021	0.208	3.031	3.014	1.09	0.26	1.903

LOT	FILAMENT DIAMETER	FILAMENT DIAMETER	THREAD COUNT	THREAD COUNT	BREAK STRENGTH	BREAK STRENGTH	#1 TGA	#2 TGA
AVERAGE	WARP	FILL	WARP	FILL	WARP	FILL	50% WT. LOSS	TEMPERATURE @
	microns	microns	---per inch---	---	lbs.	lbs.	°C	°C
LOT #1	9.25	9.91	28.6	25.0	48.7	46.3	873	
LOT #2	9.14		28.0	29.2	25.0	40.3		828
LOT #3	9.20	9.08	30.1	29.3	29.5	25.8	907	809
LOT #4	9.16	9.10	28.0	28.0	25.1	31.1	870	817
LOT #5	9.16	9.31	28.6	26.5	29.8	31.8	900	852
LOT #2R	9.73	9.99	27.8	30.0	4.7	51.0		820
AVERAGE	9.19	9.47	28.3	28.0	26.2	32.9	877	821
STD DEV	0.82	0.88	0.9	1.2	9.8	8.3	18	14
COUNT	20	5	20	20	20	20	10	10
A BASIS								
FACTOR	3.295	5.741	3.295	3.295	3.295	3.295	3.981	3.981
MINIMUM	6.49	4.44	25.4	23.9	-6.0	5.6	804	764
MAXIMUM	11.89	14.51	31.2	32.0	58.4	60.2	950	878

LOT	ATOMIC ABSORPTION					125 °C WEIGHT	600 °C	
AVERAGE	Na	K	Ca	Mg	L1 TOTAL	LOSS %	ASH %	pH units
	-----ppm-----					%	%	
LOT #1	8	3	95	2	0	108	0.005	0.087
LOT #2	2	1	104	1	0	108	-0.099	0.099
LOT #3	5	1	117	1	0	124	0.022	0.086
LOT #4	3	2	83	1	0	89	-0.015	0.050
LOT #5	5	3	38	1	0	46	0.000	0.025
LOT #2R	4	2	81	1	0	88	0.045	0.078
AVERAGE	4	2	83	1	0	90	-0.010	0.057
STD DEV	2	1	25	0	0	24	0.037	0.025
COUNT	20	20	20	20	20	20	20	20
A BASIS								
FACTOR	3.295	3.295	3.295	3.295	3.295	3.295	3.295	3.295
MINIMUM	-1	0	1	-1	0	10	-0.131	-0.026
MAXIMUM	9	4	166	2	0	171	0.111	0.139

FOOTAGE

RIGHT	START Sample	LEFT
20		
40		
60		
80		
100		
120	132 W	
140	148 W	
160	171 W	
180	188 W	
200	216 SPLICE	
220	23 W	
240		261 W
260		
280	282 W	
300	201 W 207 W	
320		
340	557 W	
360	378 W	
380		
400	416 ••	
420	435 END	
440	END Sample	
460		
480		
500		

UP READ ORIENTATION

FABRIC CCA 3-43"

MFG. HITCO

ROLL NO. 18813

YARDS 154-

POUNDS 91.3

ORDER NO. 71108

SPECIFICATION STW4-3184-SC

Q.C. FILE # NASA 1-3
SYMBOLS

- TEAR



- SPOTS OR STAINS



- FOLDS



- EDGE CURL



- TIGHT WEAVE OR SELVAGE



- WEAVE DISTORTION



- VISIBLE PUCKERS



- ONE PUCKER CREEPING



- TWO OR MORE CREEPINGS

REMARKS

NASA Roll #1-3

START END

GRADE Group CGARCON

Footage -

FT FT	START		SAMPLE
	LEFT	RIGHT	
5			
10			
20			
30			
40			
50			44 V
60			66 W
70			74 & 76 W
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			
230			
240			
250			

TREATER OPERATOR READ UP

DATE 4/15/86
 FABRIC GVB FABRIC 33
 MFG. STOCKPILE FIBERS CO LOT 1483-3

ROLL NO. 16-1708YARDS 31.0POUNDS 16.9ORDER NO. 71108SPECIFICATION STD MFG CATSQ.C. FILE # NASA# 2-1
SYMBOLS

- TEAR



- SPOTS OR STAINS



- FOLDS



- EDGE CURL



- TIGHT WEAVE OR SELVAGE



- WEAVE DISTORTION



- VISIBLE PUCKERS



- ONE PUCKER CREEPING



- TWO OR MORE CREEASING

REMARKS

GRADE Group BAM CALMA

DATE

5-20-86

FOOTAGE

		START SAMPLE	LEFT
RIGHT			
13 S		3 W 20 W 33 SPLICE BREAK	
20			
40			
60		78 SPLICE	
80			
100			
120		126 SPLICE 124 •	
140			
160			
180			
200			
220			219 S
240			
260			
280	268 S		
300		307 ••	
320		333 ••	
340			
360		367 SPLICE	
380			
400			
420			
440			
460			
480		475 ••	
500		END 518 END SAMPLE	

N C S

TREATMENT OPERATION READ UP

FABRIC UCA GRAPHITEMFG. UNION CARBIDEROLL NO. 292 4C6UCAYARDS 180.0POUNDS 99.0ORDER NO. O.E. 71108SPECIFICATION VARiousQ.C. FILE # NASA 2-1
SYMBOLS

WWW

- TEAR

E E

- SPOTS OR STAINS

△ △

- FOLDS

S

- EDGE CURL

—

- TIGHT WEAVE OR SELVAGE

W

- WEAVE DISTORTION

V

- VISIBLE PUCKERS

V

- ONE PUCKER CREEPING

V

- TWO OR MORE CREEPINGS

REMARKSGRADE Graph CFindingORIGINAL PAGE IS
OF POOR QUALITY

RT-#	START	SAMPLE	LEFT	
20				
30	EUD 30	"		
40				
50				
60				
70				
80				
90				
100	-			
110				
120				
130				
140				
150				
160				
170				
180				
190				
200				
210				
220				
230				
240				
250				

TREATMENT OPERATOR READ UP

FABRIC PWB-4

MFG. STACKPOLE Lot 1507-3

ROLL NO. 168810 A

YARDS 13.0

POUNDS 5.0

ORDER NO. 71108

SPECIFICATION STD MFG CUTS

Q.C. FILE # NASP 4-1

SYMBOLS

- TEAR



- SPOTS OR STAINS

- FOLDS

- EDGE CURL



- TIGHT WEAVE OR SELVAGE



- WEAVE DISTORTION



- VISIBLE PUCKERS



- ONE PUCKER CREEPING



- TWO OR MORE CREEPING

REMARKS

GRADE Group A

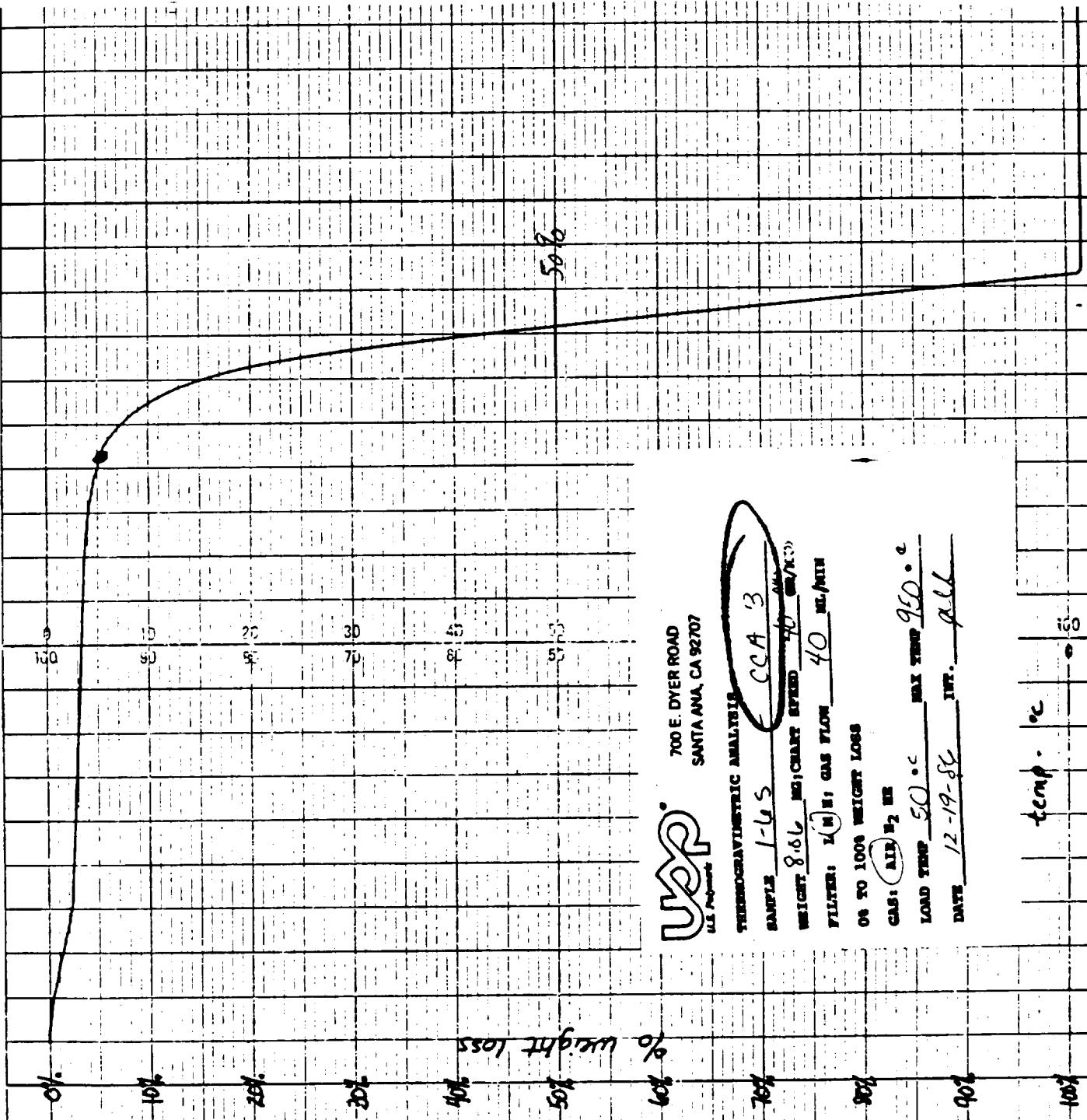
GARCIA

WEIGHT VARIATIONS
4" x 4" Dry Fabric Samples

FABRIC TYPE	NUMBER OF SAMPLES	AVERAGE WEIGHT IN GMS	STANDARD DEVIATION	TOTAL RANGE VARIATION	AVG. DIFF. IN WEIGHT LEFT TO CTR.	AVG. DIFF. IN WEIGHT RIGHT TO CTR.	MAX. VARIATION START TO END OF 1 ROLL
CCA-3 (HITCO)	120	2.85	.05	8.8%	.04 gm	.03 gm	.17 gm (5.9%)
SWB-8 (STACKPOLE)	99	3.28	.28	35.0%	.10 gm	.09 gm	.84 gm (25.6%)
WCA (UNION CARBIDE)	48	2.53	.05	8.7%	.04 gm	.02 gm	.19 gm (7.5%)
PWB-6 (STACKPOLE)	108	2.56	.18	32.4%	.09 gm	.06 gm	.61 gm (23.8%)

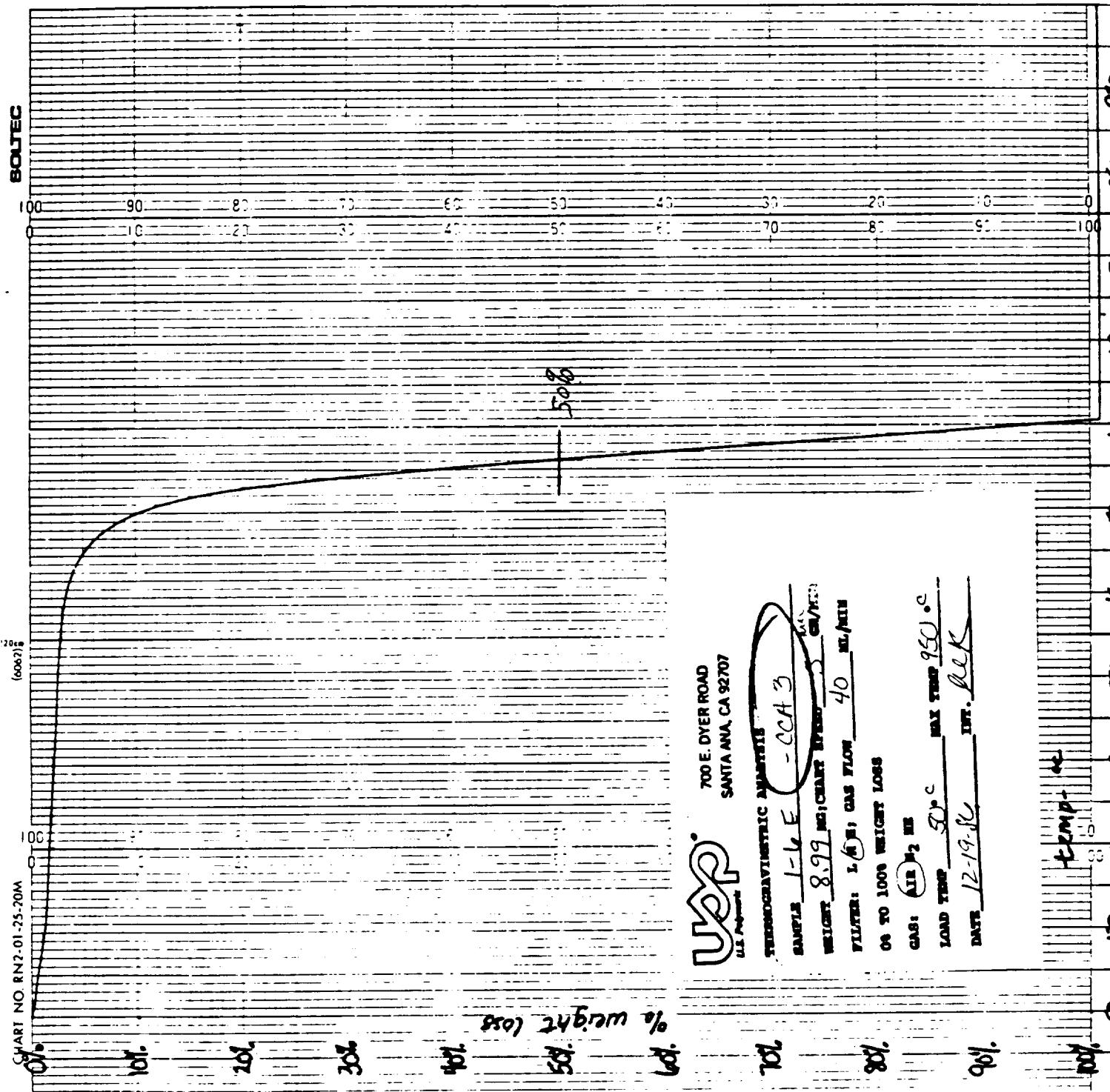
$$\frac{\text{TOTAL RANGE VARIATION} = \frac{\text{Max. Wt.} - \text{Min. Wt.}}{\text{Avg. Wt.}} \times 100}{}$$

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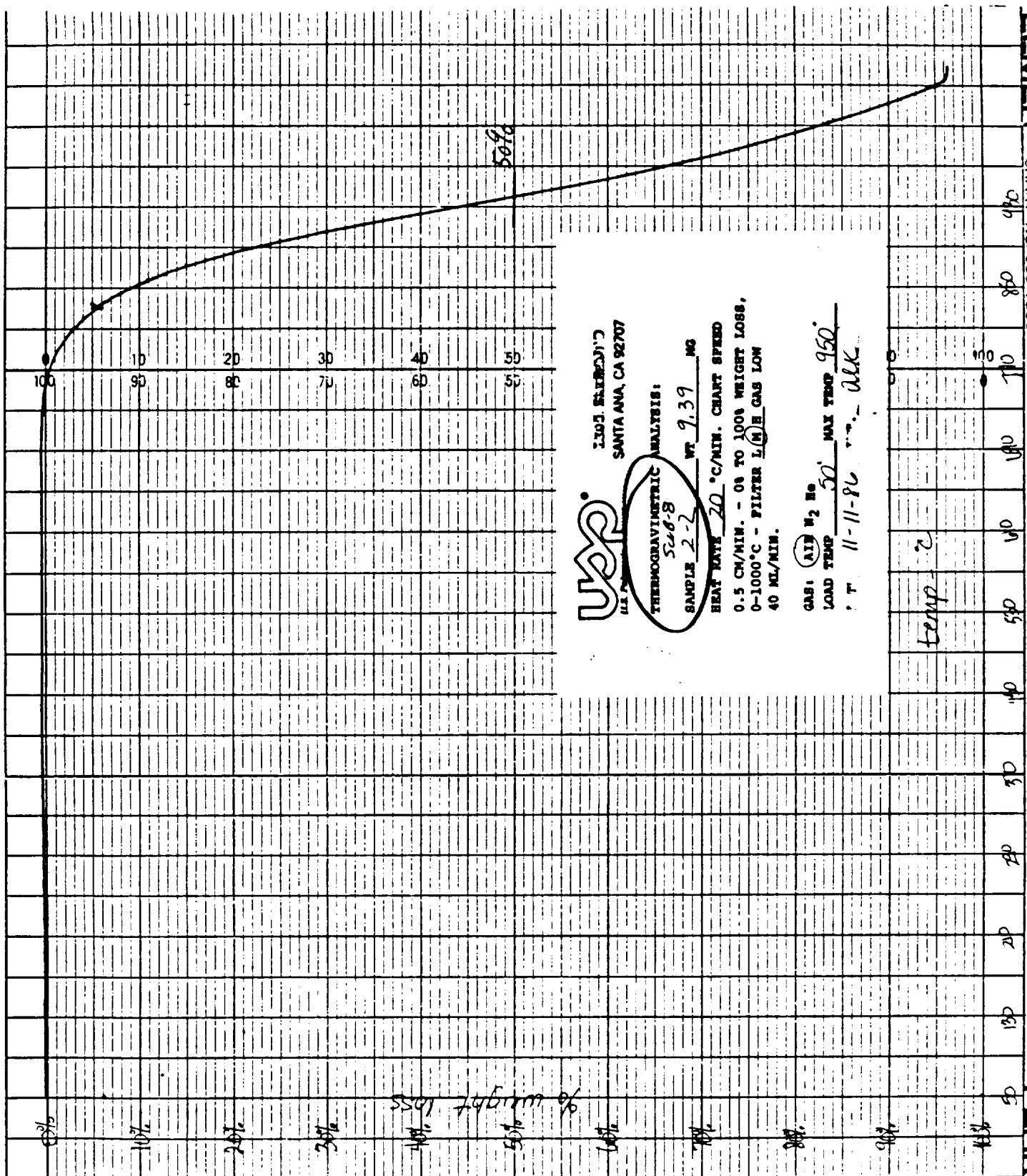


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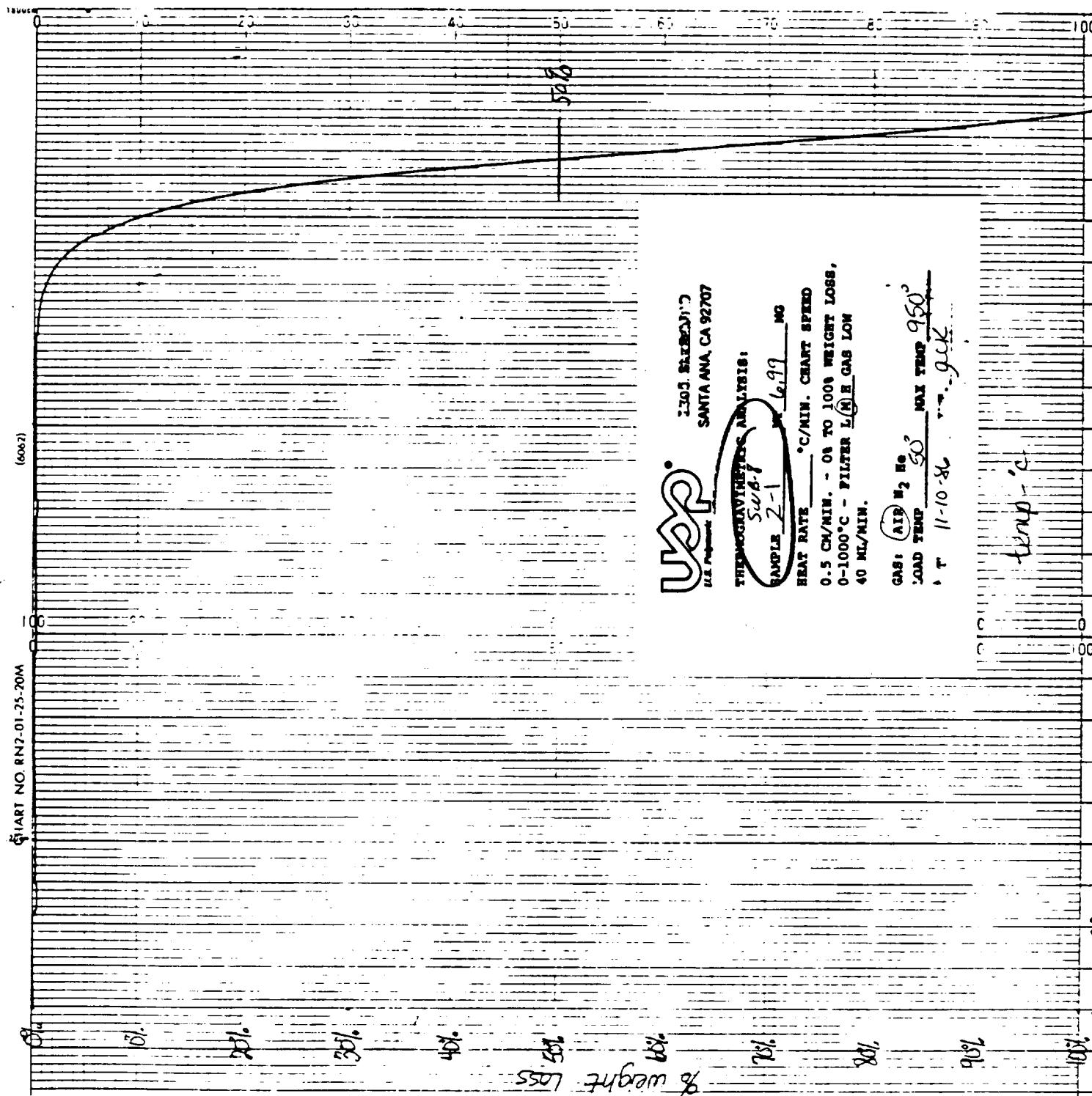
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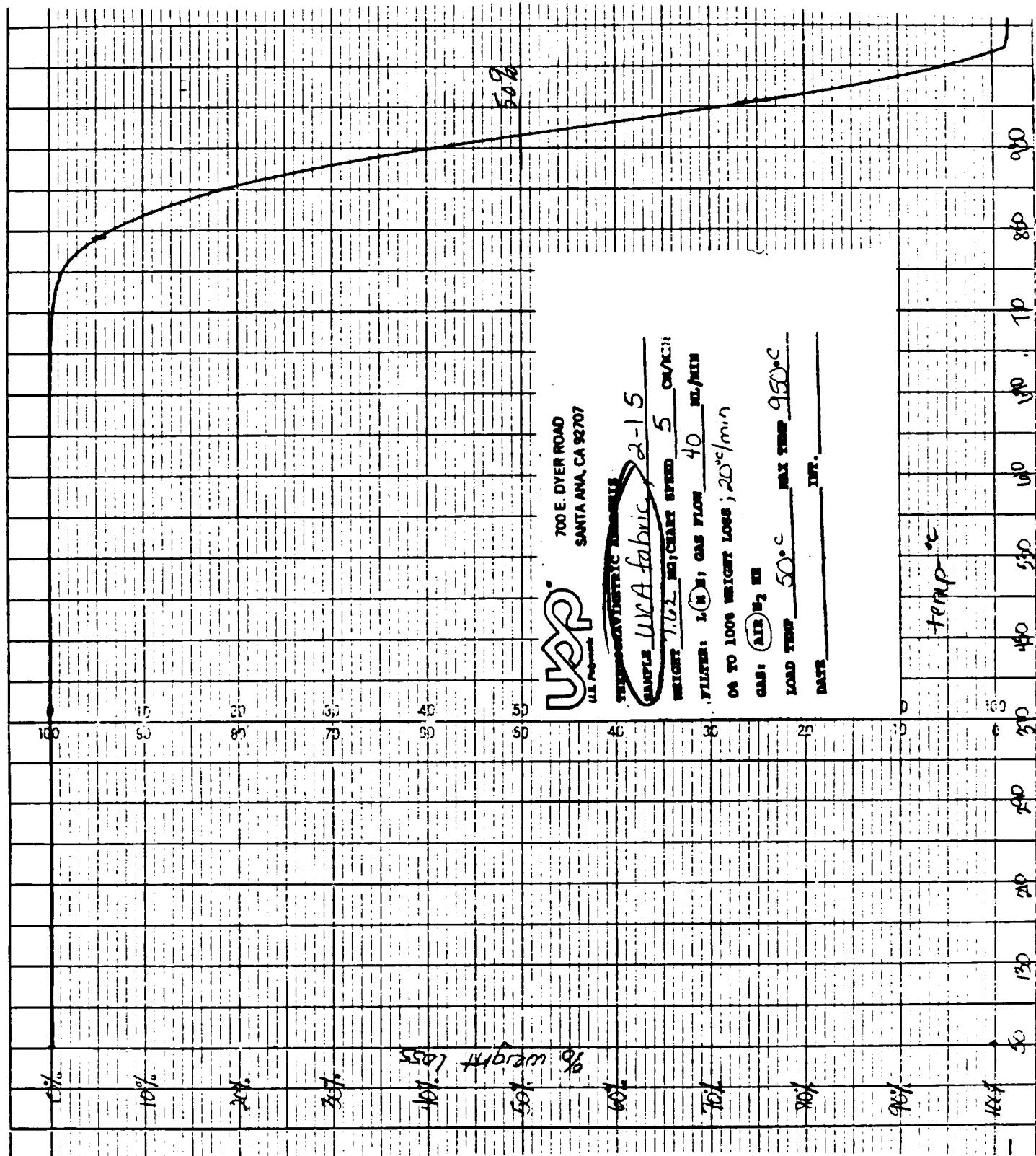


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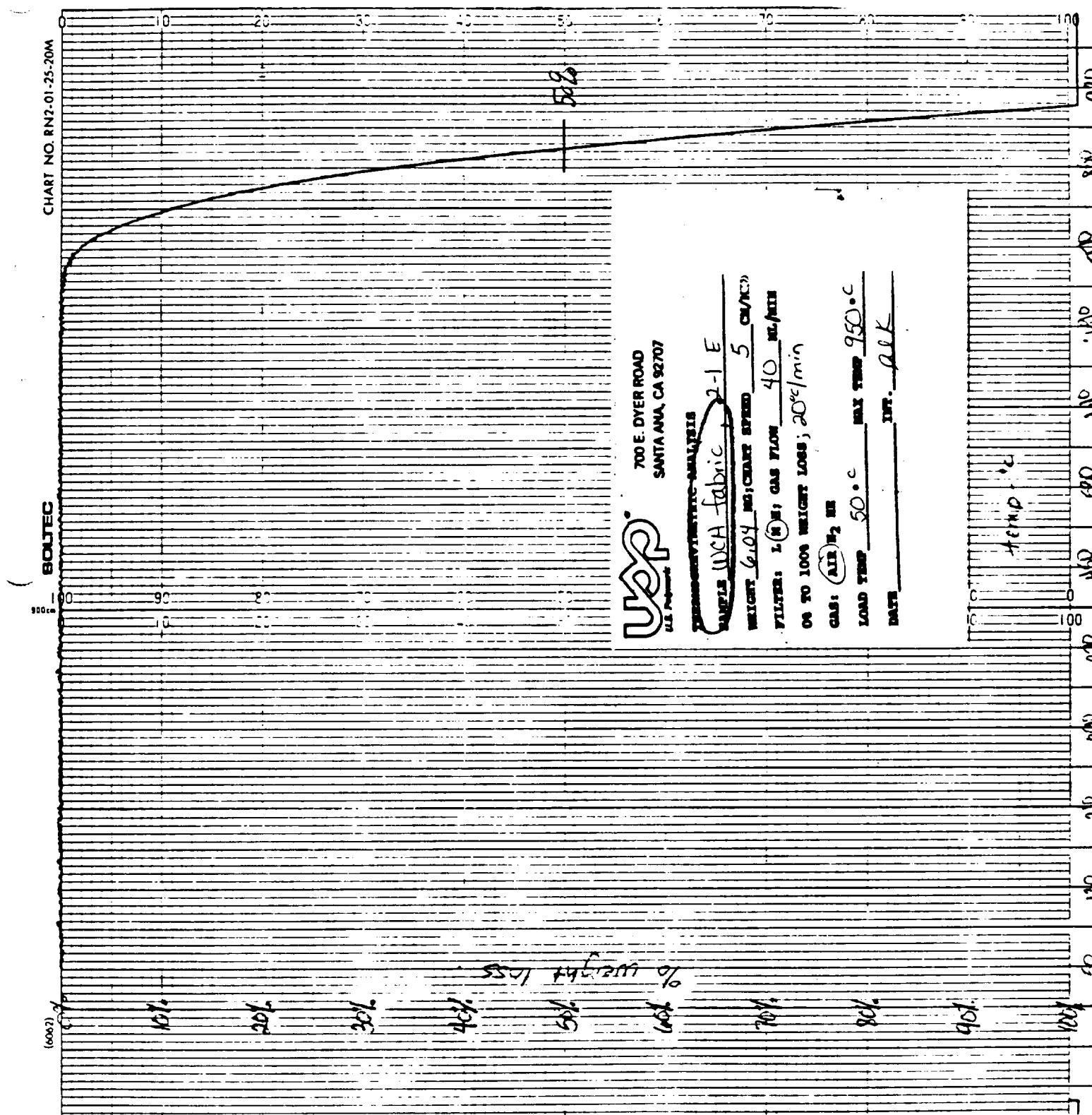


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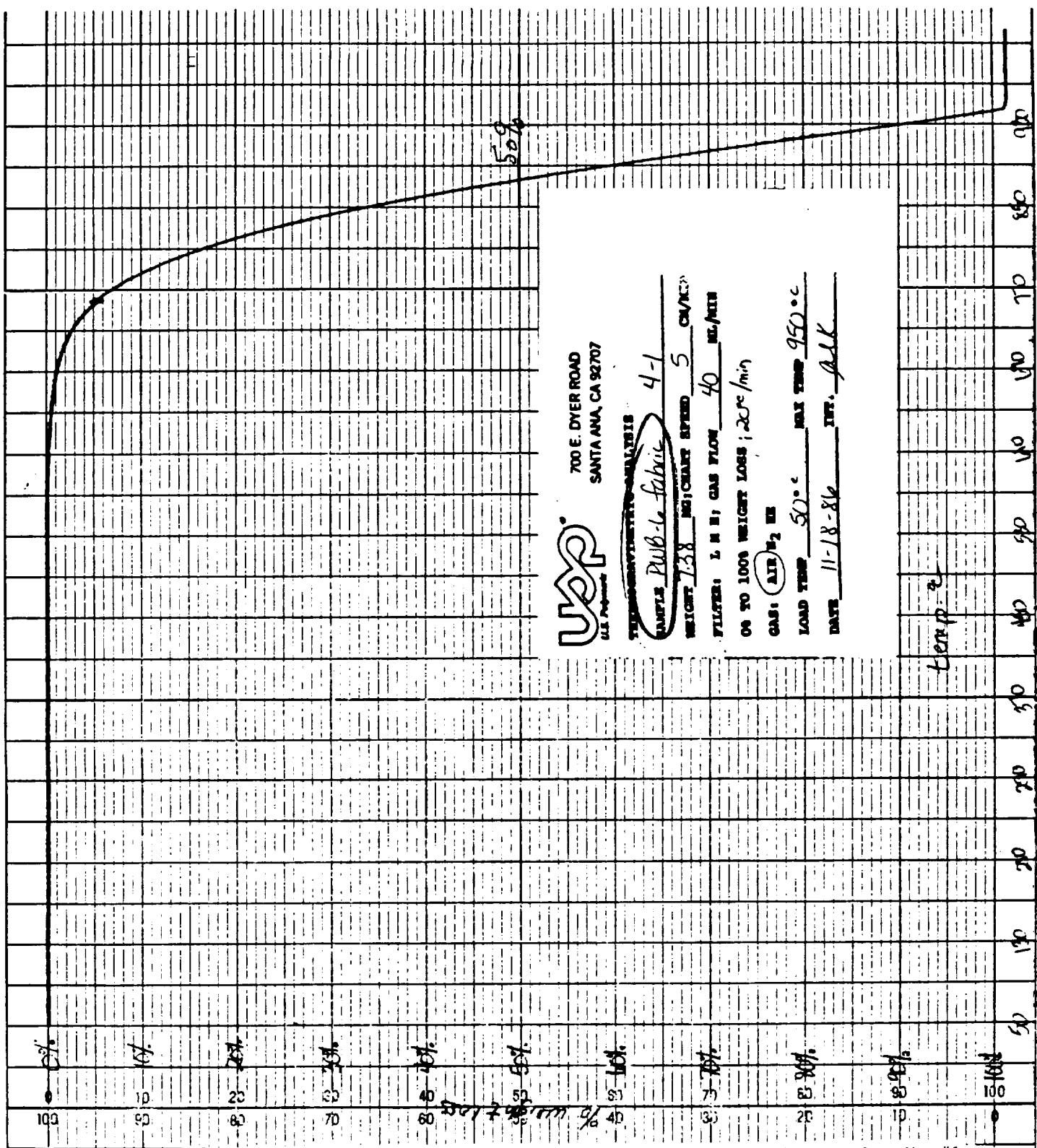


Equipment Set-Up #1



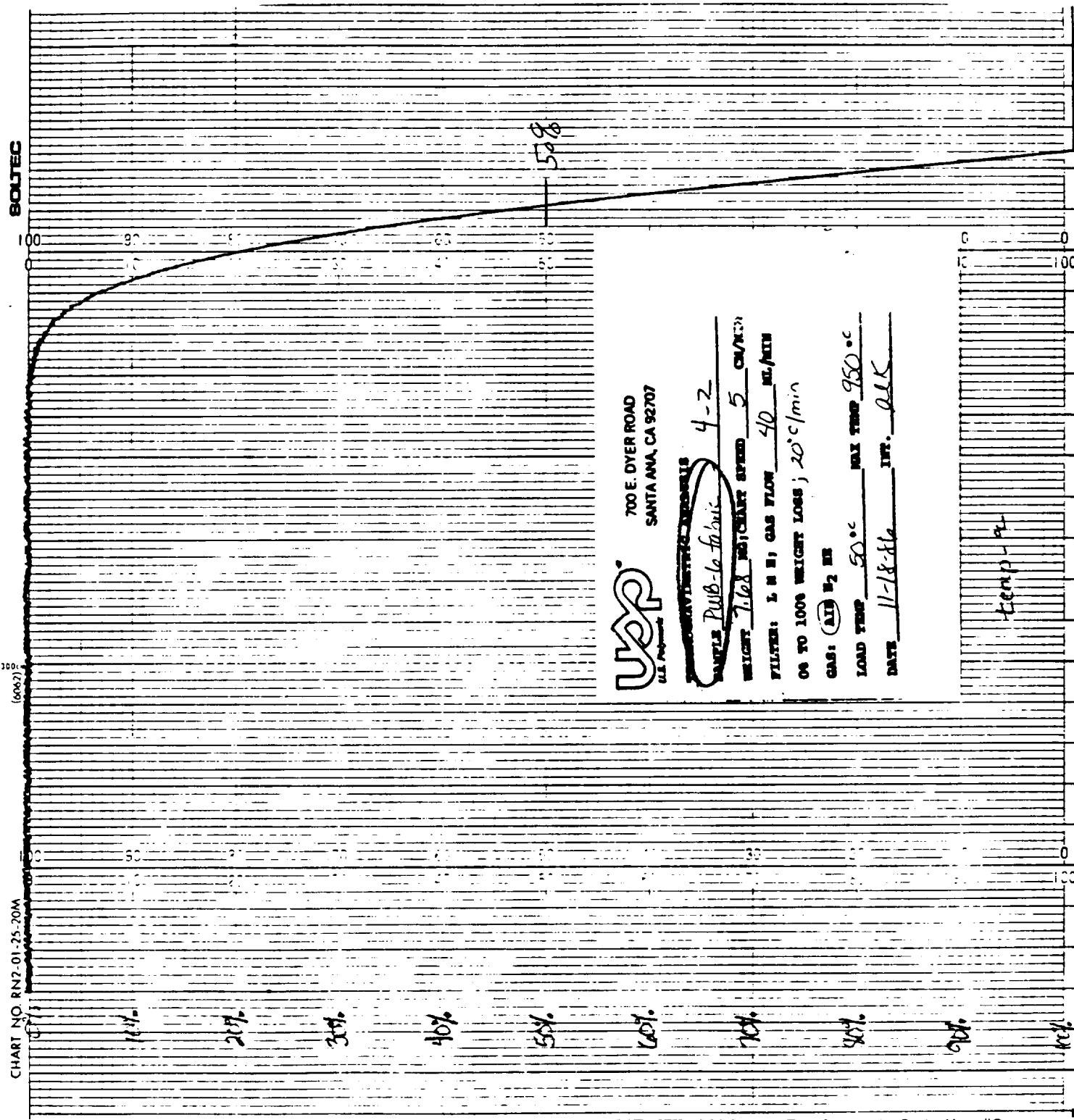
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Equipment Set-Up #1

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Equipment Set-Up #2

TABLE OF CONTENTS

UNCURED PREPREG TESTING

NAS8-36298

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	<u>PAGE</u>
I. SAMPLING PLAN.....	1
II. TEST METHODS AND OBSERVATIONS.....	2
A. Soxhlet Extractions.....	2
B. Wet Resin Flow.....	3
C. Volatile Content.....	3
D. Dry Resin Content.....	4
E. Tack.....	4
F. Gel Time.....	5
G. Infrared Baseline (IRZB).....	5
H. Thermogravimetric Analysis (TGA).....	6
I. Differential Scanning Calorimetry (DSC).....	6
J. Atomic Absorption (AA).....	7
III. SUMMARY.....	8

TABLES AND CHARTS

Comparative Uncured Prepreg Data.....	9
FM 5055B Test Results.....	12
FM 5055B Statistical Summary.....	15

	<u>PAGE</u>
FM 5834 Test Results and Statistical Summary.....	16
FM 5064J Test Results.....	19
FM 5064J Statistical Summary.....	22
FM 5839 Test Results and Statistical Summary.....	23
FM 5064J Volatile Comparisons.....	26
Typical IR Curves.....	27
Typical TGA Curves.....	31
Typical DSC Curves.....	35

UNCURED PREPREG TESTING

COMMENTS AND OBSERVATION

NAS8-36298

I. SAMPLING PLAN

For the rayon based fabrics, the resultant prepgs, FM 5055B and FM 5064J, had 1½ yards samples taken from the start and end of each nominal 100-lb. prepreg roll. The process control tests (i.e., dry resin content, volatile content, tack and wet flow measurements) were conducted for operational adjustments of the treater. Subsequent testing was conducted on the balance of the same sample. The spun PAN fabrics, FM 5834 and FM 5839 were run to nominal 40-pound prepreg rolls and sampled only at the start of each roll. Where shipment to fabricators was not required, test lots were divided into two equal rolls and both rolls were treated as individual samples. The first production for Lot #2 of FM 5839, Lot D-09281 was high in resin content (42%) versus a desired range of 32% to 37%, and the lot was redesignated Lot #2R. Testing of both uncured prepreg and cured panels for Lot #2R was completed, but not included in any of the statistical averages since the excessive resin pick-up would distort the FM 5839 summaries. Lot #2R data has been included below the listing of averages to indicate where and to what degree the higher resin content would effect the test results.

For FM 5064J, both of the fabricators, HITCO and KAISER, have individual specifications for volatile level and wet resin flow. KAISER specifies a wet resin flow tested at 1000 psi pressure with a flow range of 8-18% and a volatile level of 3.5% max. HITCO specifies a wet resin flow of 15% max tested at 150 psi pressure and allows volatile levels up to 5%. These

specifications are met by modifying treater operating parameters to provide a drier, more advanced prepreg for KAISER. All FM 5064J lots were averaged for comparative purposes but separate averages were reported on pages #19 through #21. Since several lots, HITCO Lot #2 and #3 and KAISER Lot #1 and #3, contained only 1 prepreg sample, lot averages for large lots (more than 1 sample) have been calculated on page #22. With the exception of flow and volatile contents, the data indicate there were no other significant variations due to the treater operating conditions. Comparative prepreg data is summarized on pages #9 through #11, and individual prepreg data is listed per prepreg type on pages #12 through #25.

II. TEST METHODS AND OBSERVATIONS

A. Soxhlet Extractions

The resin was extracted from the prepreg in a paper thimble by the use of ethyl alcohol under reflux for minimum of 4 hours. By using the volatile content of the sample and a difference in weight of the dried thimble before and after extraction, the resin content was determined. Since the filler content of the resin mix used on the treater was known, the filler content of the prepreg was calculated; and the cloth content determined by a material balance. The spun PAN prepgs, FM 5834 and FM 5839, show roughly 2-3 times the amount of variation in resin content than the rayon fabrics since the resin metering system which was used is partially dependent on the uniformity of the raw fabric. Other than FM 5839 Lot #2R which was out of the acceptable range of Soxhlet resin content (page #23), and FM 5834 Lot #5 and FM 5839 Lot #3 which were both slightly higher in resin content, no other significant deviations were noted from the Soxhlet extraction results.

B. Wet Resin Flow

A four-ply biased panel, 4 in. x 4 in. square, was cured at 150 psi pressure (or 1000 psi in the case of KAISER FM 5064 and FM 5839) at a temperature of 163°C (325°F) for 10 minutes, and the amount of resin flow determined by flash removal. The "wet resin" terminology indicates that the prepreg is tested before devolatilization. The significance of flow values is best determined on a roll by roll basis at the time of fabrication because there is significant variation of flow values between rolls in a lot. FM 5839 Lot #4, treater Lot D-09317, rolls #4, 5 and 6; and FM 5839 Lot #5, treater lot D-09318, rolls #1 and 2 were both redried, i.e., run through another pass on the treater to reduce the resin flows to acceptable levels.

C. Volatile Content

A single 4" x 4" bias ply of prepreg was dried in a 163°C (325°F) forced air oven for 10 minutes and the weight difference used to calculate volatile content as a percentage of the original weight. FM 5834 Lot #5, treater Lot #D-09336 had to be redried to bring the volatile content to an acceptable level. The significance of volatile content can best be determined on a roll by roll basis at the time of fabrication. Correlation between residual vols of the prepreg and residual vols of the cured panel shows a correlation coefficient (r^2) of 0.015 for FM 5055B, 0.134 for FM 5834, 0.266 for FM 5839; and 0.465 for FM 5064J. The plot of residual volatiles versus prepreg volatiles for FM 5064 is shown on page #26. This apparent correlation is caused by the two different treater conditions, resulting in the data being grouped by fabricator - HITCO versus KAISER.

D. Dry Resin Content

One of the process control tests is a dry resin content which utilizes the same 4" x 4" bias ply which had been devolatilized for the volatile content determination and subtracts the dry fabric weight previously determined to allow a quick calculation of the resin content. Normally, dry resin contents are 1½% to 2% higher than those determined by Soxhlet extraction, but the test accuracy depends heavily on fabric uniformity. The three to four fold higher variation in dry resin content of spun PAN prepreg reflect back to the variations in fabric weight mentioned in the fabric discussion.

The spun PAN fabrics, due to the lack of uniformity in filament orientation, had an inherent tendency to pick up more resin than the uniformly oriented rayon fabrics. To demonstrate the ability to tailor-make a prepreg in order to get a comparable carbon/phenolic prepreg from SWB-8 for tape wrapping, based on the handleability and fabricability (that is, equivalent tack and resin flow), spun PAN required almost 40% dry resin content compared to CCA-3 dry resin contents of 34-35%. Likewise, PWB-6 naturally needs a higher resin content to be equivalent in handling and fabricability to WCA.

E. Tack

To attempt to quantify the fabricability of prepreg in light of the customer's needs, a tack test was used where 1 square inch overlap of prepreg is heated for 60 seconds in a 190°F press, under 50 psi, removed, and cooled between two (2) caul plates to room temperature. The load required to separate this overlap section is used as an indication of the fabricability of the prepreg and is usually compared to a minimum load requirement. Since the primary driver for tack is the resin advancement, no particular deviations were noted with the exception of FM 5839 lots #4 and #5 which were redried, reducing the tack below

lots which had not been redried. A different type of tack test was proposed for tape wrap carbon/phenolic prepreg in the proposed specifications (Volume II).

F. Gel Time

The isothermal gel time of prepreg at 163°C (325°F) was determined by pressing a stack of 16-20 two-inch squares of prepreg in a 163°C (325°F) press, adjusting the pressure until a 1/4 inch bead of extruded resin was present around the squares. This bead was probed until gelation occurred and the elapsed time noted. Note the longer gel times of the carbon/phenolic prepgs, FM 5055B and FM 5834, (both made with 91LD resin) compared to the carbon carbon prepgs made with USP 39A. The difference in basic resin properties is the primary determinant; but treater conditions helped to narrow the differences, i.e., 91LD raw resin takes about twice as long to gel as USP 39A (225 sec. versus 110 sec.). But after processing, the difference is reduced to 92 sec. versus 69 sec. The variability of gel time data makes correlations impractical.

G. Infrared Baseline (IRZB)

The infrared method of the determination of the degree of advancement differentiates the molecular structure changes which result from resin polymerization. This test involves solvating the resin from the prepg using acetone, calibration of companion sodium chloride cells, adjustment of resin extract concentration to give a reference absorbance and determining the ratios of the log of absorbance at 12.15 and 9.8 microns. For USP 39A, constituent materials shift the peak normally found in phenolic resins from 9.8 microns to approximately 9.55 microns. For comparative purposes in this project, the 9.55 microns peak was used for calculation of the ratios. While not within the classical definition of the polymerization index (or baseline) for USP 39A, the peak values

at 9.55 microns are more precise than readings taken on the vertical section of the IR curve. This prevents the direct comparison of IR ratios between USP 39A and 91LD resin. Typical charts for each prepreg are shown on pages #27 through #30. Charts for each individual prepreg sample are shown in the appropriate lot fingerprint.

H. Thermogravimetric Analysis (TGA)

All of the prepreg tests for weight loss of prepreg in a nitrogen atmosphere for temperatures up to 1000°C (1832°F), were conducted in a Perkin-Elmer TGS-2 thermal analyzer with a Perkin-Elmer DSC-2 programmer without a feedback loop. The only noticeable variation was in FM 5834 which only attained the level of 7.0% weight loss at 500°C (932°F) versus 9.1% to 9.7% for the other prepgs. A typical chart of each prepreg is shown on pages #31 through #34. TGA results from each individual prepreg samples are shown in the appropriate lot fingerprint.

I. Differential Scanning Calorimetry (DSC)

When the heat flow (enthalpy) of a prepreg sample is plotted against temperature of up to 350°C (662°F), carbon/carbon prepgs based on USP 39A show a single exotherm with a peak in the range of 183°C-184°C (361°F-363°F), as shown on pages #37 and #38. The carbon/phenolic prepreg with 91LD resin, however, show the expected peak exotherm at 178°C-180°C (352°F-356°F) range as well as a secondary exotherm at 238°C-240°C (460°F-464°F), as shown on pages #35 and #36. This second peak is distinguishable enough to be measured on all 91LD prepreg samples. This second peak is presumed to be related to a secondary crosslinking reaction. It should be noted that the DSC peak exotherm is different from an isothermal gel time discussed in Item F above, because the DSC is subjected to a programmed heating rate, 20°C per minute, rather than being held at a constant temperature.

COMPARISON OF PEAK DSC EXOTHERM TEMPERATURESDSC RESIN

91 LD - 183°

USP 39A - 188°C

DSC PREPREG

FM 5055B - 178°C

FM 5834 - 180°C

FM 5064J - 183°C

FM 5839 - 184°C

DSC plots for each individual prepreg samples are shown in the individual lot fingerprint only.

J. Atomic Absorption (AA)

The ash from a 600°C (1,112°F) pyrolysis for 16-20 hours was digested with hydrochloric acid and compared for light absorption with accurately prepared alkaline metal standards of 0.5 ppm. It was noted that the magnesium level in CCA-3 (average of 56 ppm) was not traceable to FM 5055B prepreg at the expected level (i.e., 51.5% Soxhlet cloth content should contribute 29 ppm magnesium in the prepreg). Observed magnesium levels in FM 5055B averaged 3 ppm versus the 29 ppm predicted and the difference is believed to be influenced by the presence of other alkaline metals or in the standard preparation. The relatively high level of sodium in Lot #4 of USP 39A resin is traceable to its resultant prepgs with Lot #4 of FM 5064J and FM 5839, both being proportionately higher in sodium than the other lots. Overall, comparing the total level of alkaline impurities observed in the prepreg testing to the predicted levels based on the proportional contribution of filler, resin, and fabric using Soxhlet percentages, the following table was compiled:

TOTAL ALKALINE IMPURITIES

<u>PREPREG TYPE</u>	<u>AVG. PREDICTED</u>	<u>AVG. OBSERVED</u>	<u>PERCENTAGE</u>
	<u>TOTAL PPM</u>	<u>TOTAL PPM</u>	<u>OF PREDICTED</u>
FM 5055B	369	414	112
FM 5834	39	48	125
FM 5064J (HITCO)	30	17	56
FM 5064J (KAISER)	29	20	69
FM 5839	65	43	65

It is readily apparent that the carbon/phenolic prepgs exhibited higher impurity levels in the prepg than predicted from their constituents, and all of the carbon/carbon prepgs exhibited alkaline levels lower than predicted. No explanation is available for this at the present time.

III. SUMMARY

From the uncured prepg testing, several physical properties such as resin gel temperatures and some alkaline metal impurity levels can be traced through to the prepg. The primary influence of raw material, observed in this study, is the amount of variation in the spun PAN fabrics compared to the continuous rayon fabrics. The large fabric variation, evidenced as weight variations, make process control and product uniformity very difficult and vastly increased any proposed specification ranges based on the test procedures utilized in the study.

COMPARATIVE UNCURED PREPREG DATA

NAS8-36298

CARBON/PHENOLIC PREPREGS

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FM 5055B

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	SOXHLET GRAND TOTAL	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 150 psi	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
AVERAGE	34.2	14.3	51.5	17.4	4.1	34.2	
STD DEV	1.1	0.5	1.5	2.5	0.3	1.1	
MINIMUM	32.1	13.3	48.2	11.3	3.6	32.1	
MAXIMUM	36.6	15.3	54.6	21.0	4.9	37.7	

FM 5834

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	SOXHLET GRAND TOTAL	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 150 psi	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
AVERAGE	37.3	15.7	47.0	15.7	4.8	39.7	
STD DEV	2.6	1.2	3.8	3.9	0.7	2.8	
MINIMUM	31.6	13.9	39.0	9.4	3.7	31.7	
MAXIMUM	42.6	18.4	54.5	19.7	5.8	42.8	

CARBON/CARBON PREPREGS

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FM 5064J

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	SOXHLET GRAND TOTAL	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
AVERAGE	33.7	14.1	52.3	--	2.8	34.2	
STD DEV	1.0	0.4	1.2	--	0.4	0.8	
MINIMUM	31.5	13.4	50.2	9.1	2.0	32.6	
MAXIMUM	35.3	15.0	54.7	18.0	3.5	35.3	

FM 5839

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	SOXHLET GRAND TOTAL	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 1000 psi	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
AVERAGE	34.2	14.4	51.5	13.1	2.5	35.7	
STD DEV	1.9	0.9	2.7	3.4	0.3	2.5	
MINIMUM	29.0	12.3	48.1	8.6	2.2	30.3	
MAXIMUM	36.8	15.4	58.7	18.8	3.2	41.3	

COMPARATIVE UNCURED PREPREG DATA

NAS8-36298

CARBON/PHENOLIC PREPREGS

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FM 5055B

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	TACK GRAND TOTAL 1bs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500°C % 9.7	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
AVERAGE	44	84	1.11	9.7	178	238
STD DEV	12	27	0.02	1.0	1	3
MINIMUM	20	32	1.07	5.9	174	232
MAXIMUM	72	123	1.15	11.3	180	244

FM 5834

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	TACK GRAND TOTAL 1bs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500°C % 7.0	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
AVERAGE	40	100	1.10	7.0	180	241
STD DEV	10	54	0.04	1.0	2	2
MINIMUM	20	58	1.03	4.9	177	239
MAXIMUM	60	207	1.15	8.8	183	243

CARBON/CARBON PREPREGS

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FM 5064J

=====

	TACK GRAND TOTAL 1bs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500 °C % 9.3	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
AVERAGE	35	70	0.81	9.3	183	
STD DEV	11	16	0.03	1.3	1	
MINIMUM	15	34	0.76	6.4	180	
MAXIMUM	58	96	0.92	10.9	185	

FM 5839

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	TACK GRAND TOTAL 1bs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500 °C % 9.1	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
AVERAGE	19	68	0.82	9.1	184	
STD DEV	11	22	0.02	1.0	1	
MINIMUM	8	32	0.79	7.5	183	
MAXIMUM	38	97	0.87	11.9	186	

COMPARATIVE UNCURED PREPREG DATA

NAS8-36298

CARBON/PHENOLIC PREPREGS

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FM 5055B

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GRAND TOTAL	-----ATOMIC ABSORPTION-----					PERCENT MOISTURE	PERCENT ASH
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm		
AVERAGE	387	21	3	3	0	414	5.60
STD DEV	88	4	2	2	0	88	0.82
MINIMUM	240	13	0	0	0	261	4.54
MAXIMUM	578	29	9	7	0	598	7.41

FM 5834

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GRAND TOTAL	-----ATOMIC ABSORPTION-----					PERCENT MOISTURE	PERCENT ASH
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm		
AVERAGE	11	2	34	1	0	48	3.20
STD DEV	5	1	34	0	0	34	0.29
MINIMUM	5	1	12	1	0	23	2.83
MAXIMUM	22	3	148	2	0	160	3.77

CARBON/CARBON PREPREGS

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FM 5064J

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GRAND TOTAL	-----ATOMIC ABSORPTION-----					PERCENT MOISTURE	PERCENT ASH
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm		
AVERAGE	10	1	6	2	0	19	2.04
STD DEV	8	1	5	1	0	11	0.20
MINIMUM	1	0	0	1	0	4	1.76
MAXIMUM	26	2	13	6	0	40	2.44

FM 5839

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GRAND TOTAL	-----ATOMIC ABSORPTION-----					PERCENT MOISTURE	PERCENT ASH
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm		
AVERAGE	20	2	19	2	0	43	2.25
STD DEV	12	1	8	2	0	13	0.68
MINIMUM	5	1	5	1	0	18	1.82
MAXIMUM	36	4	34	8	0	61	4.48

FM 5055B UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	SOXHLET RESIN CONTENT %	SOXHLET FILLER CONTENT %	SOXHLET CLOTH CONTENT %	WET FLOW 150 psi	VOLATILE CONTENT 325°F %	DRY RESIN CONTENT %
#	TEST METHOD	CTM-6D	CTM-6D	CTM-6D	PTM-19G	PTM-17B	PTM-16F
#1	D09256-S1	33.4	13.8	52.8	19.5	4.6	33.9
	-E1	35.7	14.8	49.5	20.1	4.7	34.5
	-S2	34.2	14.2	51.5	19.5	4.7	37.7
	-E2	36.6	15.2	48.2	19.9	4.6	35.2
	-S3	35.6	14.8	49.6	20.0	4.9	36.4
	-E3	36.2	15.0	48.9	19.8	4.3	34.8
	-S4	34.6	14.4	51.0	19.2	4.2	34.6
	-E4	36.4	15.1	48.5	19.1	4.2	35.2
	-S5	34.7	14.4	50.9	19.3	4.5	34.1
	-E5	33.2	13.9	52.9	17.2	3.9	32.6
	-S6	34.4	14.2	51.4	17.8	4.1	34.8
	-E6	33.8	14.0	52.2	16.5	3.8	33.8
	-S7	35.5	14.7	49.8	18.0	4.1	34.1
	-E7	33.1	13.7	53.1	16.3	3.8	33.6
	-S8	32.1	13.3	54.6	11.8	3.8	32.1
	-E8	34.7	14.4	50.9	17.1	3.9	32.4
	-S9	32.9	13.7	53.4	16.3	3.8	32.3
	-E9	33.3	13.8	52.9	14.8	4.0	32.7
#2	D09274-S1	33.5	13.9	52.6	19.2	4.5	34.6
	-E1	33.5	14.0	52.5	20.0	4.1	32.7
	-S2	32.4	13.5	54.1	20.0	4.3	33.1
	-E2	34.3	14.3	51.4	19.4	4.0	34.9
	-S3	33.8	14.1	52.1	18.9	4.7	36.1
	-E3	34.4	14.3	51.3	19.4	4.2	33.1
	-S4	34.2	14.2	51.6	19.7	4.3	35.5
	-E4	36.0	15.0	49.0	13.4	3.7	33.3
	-S5	33.9	14.1	52.0	13.7	3.8	33.3
	-E5	34.5	14.4	51.1	19.5	4.4	35.0
	-S6	33.8	14.1	52.2	19.3	4.0	34.0
	-E6	33.1	13.8	53.1	19.0	4.1	34.2
	-S7	33.8	14.1	52.1	15.5	4.2	33.1
	-E7	34.1	14.2	51.7	17.5	4.2	33.1
	-S8	33.9	14.1	52.0	16.6	4.2	33.5
	-E8	33.7	14.1	52.2	17.5	4.2	34.2
	-S9	34.4	14.3	51.3	16.9	4.1	34.2
	-E9	34.4	14.3	51.2	18.5	4.2	34.9
#3	C02133-S1	34.4	14.5	51.1	18.5	4.4	36.1
	-E1	34.2	14.4	51.4	16.1	3.7	34.4
	-S2	35.9	15.1	49.0	17.8	4.1	35.7
	-E2	36.5	15.3	48.2	13.9	3.8	34.0
	-S3	32.8	13.8	53.4	13.6	3.6	33.7
	-E3	33.9	14.2	51.9	17.6	3.6	32.9
	-S4	32.8	13.7	53.5	11.3	3.8	34.8
	-E4	34.0	14.3	51.7	11.9	3.8	33.5
	-S5	33.9	14.2	51.8	13.6	3.8	34.5
	-E5	33.4	14.0	52.6	14.1	3.7	34.3
	-S6	33.8	14.2	51.9	15.3	3.7	34.1
	-E6	34.9	14.7	50.4	17.7	4.1	34.9
	-S7	35.1	14.7	50.2	17.8	4.1	34.9
	-E7	32.5	13.6	53.9	19.2	3.8	32.9
#4	D09313-S1	33.3	14.7	52.0	13.4	4.3	35.5
	-S2	34.6	15.2	50.2	21.0	4.5	34.7
#5	D09335-S1	34.7	15.0	50.3	17.7	4.3	33.9
	-S2	33.4	14.4	52.2	20.2	4.3	34.5

FM 5055B	SOXHLET GRAND TOTAL CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 150 psi	VOLATILE CONTENT 325°F %	DRY RESIN CONTENT %
AVERAGE	34.2	14.3	51.5	17.4	4.1	34.2
STD DEV	1.1	0.5	1.5	2.5	0.3	1.1
MINIMUM	32.1	13.3	48.2	11.3	3.6	32.1
MAXIMUM	36.6	15.3	54.6	21.0	4.9	37.7

FM 5055B UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TACK	GEL	INFRA-	T. G. A.	DSC	DSC
		50 psi	190°F	TIME sec	RED IRZB	WT LOSS @ 500°C	EXOTHERM 1st TEMP °C
		1bs	325°F		ratio	%	EXOTHERM 2nd TEMP °C
	TEST METHOD		QAI-5070	PTM-20E	CTM-21C	CTM-51	CTM-50A
#1	D09256-S1	45	89		1.09	11.3	177
	-E1	62	75		1.13	10.4	178
	-S2	48	85		1.14	10.2	179
	-E2	60	113		1.15	10.9	178
	-S3	45	114		1.12	11.0	179
	-E3	52	123		1.12	11.2	176
	-S4	55	113		1.15	11.0	177
	-E4	58	108		1.11	10.4	178
	-S5	52	119		1.10	10.5	177
	-E5	37	98		1.10	10.6	179
	-S6	35	109		1.11	9.8	177
	-E6	72	116		1.09	10.2	180
	-S7	43	96		1.12	9.9	178
	-E7	56	102		1.10	10.1	178
	-S8	38	98		1.13	--	178
	-E8	48	110		1.11	9.5	178
	-S9	61	119		1.10	10.2	178
	-E9	36	109		1.13	10.2	178
#2	D09274-S1	63	118		1.11	10.0	176
	-E1	49	97		1.11	9.8	176
	-S2	46	98		1.08	10.0	178
	-E2	40	92		1.10	9.5	178
	-S3	45	90		1.07	10.1	179
	-E3	50	104		1.10	9.7	177
	-S4	45	94		1.10	9.3	178
	-E4	20	75		1.10	9.4	177
	-S5	28	81		1.08	8.2	178
	-E5	42	110		1.08	9.6	180
	-S6	30	101		1.09	8.9	179
	-E6	36	93		1.10	9.4	178
	-S7	49	88		1.11	9.3	176
	-E7	37	91		1.09	9.6	178
	-S8	36	87		1.11	9.1	176
	-E8	34	86		1.08	8.8	176
	-S9	29	98		1.09	--	--
	-E9	42	102		1.11	8.3	176
#3	C02133-S1	32	63		1.13	10.9	180
	-E1	50	95		1.13	9.7	175
	-S2	56	61		1.13	9.6	177
	-E2	28	38		1.07	9.4	179
	-S3	45	55		1.11	9.1	176
	-E3	54	50		1.11	9.5	174
	-S4	40	44		1.11	10.4	179
	-E4	41	32		1.10	9.5	178
	-S5	45	49		1.11	10.1	178
	-E5	50	42		1.08	5.9	179
	-S6	59	56		1.11	8.9	179
	-E6	63	36		1.10	10.1	178
	-S7	65	40		1.15	10.3	178
	-E7	29	35		1.14	11.1	178
#4	D09313-S1	25	64		1.12	9.7	179
	-S2	32	63		1.11	10.3	179
#5	D09335-S1	35	58		1.14	8.0	179
	-S2	27	50		1.13	7.4	178

FM 5055B	TACK	GEL	INFRA-	T. G. A.	DSC	DSC
GRAND TOTAL	50 psi	TIME	RED	WT LOSS	EXOTHERM	EXOTHERM
	190°F	325°F	IRZB	@ 500°C	1st TEMP °C	2nd TEMP °C
	1bs	sec	ratio	%		
AVERAGE	44	84	1.11	9.7	178	238
STD DEV	12	27	0.02	1.0	1	3
MINIMUM	20	32	1.07	5.9	174	232
MAXIMUM	72	123	1.15	11.3	180	244

EM 5055B UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT and SAMPLE	ATOMIC ABSORPTION						PERCENT MOISTURE %	PERCENT ASH %
		Alkaline Impurities							
TEST METHOD		Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm		
#1	D09256-S1	497	24	2	1	0	524	7.10	0.26
	-E1	578	18	1	1	0	598	6.55	0.21
	-S2	418	27	1	0	0	446	6.31	0.12
	-E2	492	24	1	2	0	519	6.76	0.18
	-S3	501	21	2	1	0	525	6.70	0.16
	-E3	420	18	2	1	0	441	6.93	0.20
	-S4	311	22	1	1	0	335	6.86	0.12
	-E4	400	19	0	1	0	420	6.80	0.14
	-S5	315	20	2	2	0	339	6.56	0.12
	-E5	308	15	2	1	0	326	5.96	0.13
	-S6	283	27	0	0	0	310	6.41	0.16
	-E6	419	17	2	1	0	439	5.88	0.23
	-S7	240	19	1	1	0	261	6.71	0.13
	-E7	263	19	2	1	0	285	6.29	0.13
	-S8	536	21	1	2	0	560	7.41	0.13
	-E8	277	27	0	2	0	304	6.55	0.18
	-S9	352	28	2	1	0	383	6.69	0.13
	-E9	509	17	1	2	0	529	6.64	0.16
#2	D09274-S1	439	23	5	5	0	472	5.07	0.19
	-E1	467	25	8	6	0	506	4.69	0.16
	-S2	368	23	4	6	0	400	4.80	0.18
	-E2	393	22	6	6	0	427	5.17	0.18
	-S3	401	23	3	4	0	431	5.29	0.28
	-E3	436	23	8	7	0	474	5.27	0.21
	-S4	417	19	4	6	0	446	4.88	0.20
	-E4	328	19	7	6	0	360	4.85	0.19
	-S5	346	19	4	5	0	374	4.69	0.14
	-E5	471	24	4	5	0	504	4.73	0.24
	-S6	473	25	3	5	0	506	4.54	0.26
	-E6	418	19	5	5	0	447	4.93	0.22
	-S7	336	21	6	6	0	369	4.77	0.22
	-E7	384	22	6	4	0	416	5.00	0.22
	-S8	282	20	4	6	0	312	4.56	0.20
	-E8	263	22	4	4	0	293	4.66	0.18
	-S9	--	--	--	--	--	--	--	--
	-E9	259	21	3	5	0	288	4.59	0.19
#3	CO2133-S1	344	19	2	2	0	367	5.22	0.16
	-E1	438	17	2	2	0	459	5.19	0.11
	-S2	436	20	2	2	0	460	5.13	0.07
	-E2	428	20	2	3	0	453	5.48	0.12
	-S3	276	16	2	2	0	296	5.05	0.21
	-E3	309	15	3	1	0	328	4.99	0.12
	-S4	399	17	3	1	0	420	5.06	0.15
	-E4	456	14	2	1	0	473	4.86	0.19
	-S5	454	15	2	2	0	473	5.12	0.18
	-E5	382	18	2	2	0	404	5.03	0.17
	-S6	500	20	2	1	0	523	5.24	0.20
	-E6	494	21	2	3	0	520	5.42	0.31
	-S7	533	22	2	2	0	559	5.34	0.26
	-E7	288	18	2	2	0	310	5.21	0.23
#4	D09313-S1	353	18	7	4	0	382	5.17	0.15
	-S2	334	13	9	5	0	361	5.28	0.18
#5	D09335-S1	248	29	2	3	0	282	6.19	0.14
	-S2	249	23	2	5	0	279	6.14	0.12

GRAND TOTAL	ATOMIC ABSORPTION						PERCENT MOISTURE %	PERCENT ASH %
	Alkaline Impurities							
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm		
AVERAGE	387	21	3	3	0	414	5.60	0.18
STD DEV	88	4	2	2	0	88	0.82	0.05
MINIMUM	240	13	0	0	0	261	4.54	0.07
MAXIMUM	578	29	9	7	0	598	7.41	0.31

FM 5055B UNCURED PREPREG
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	SOXHLET RESIN CONTENT %	SOXHLET FILLER CONTENT %	SOXHLET CLOTH CONTENT %	WET FLOW 150 psi	VOLATILE CONTENT 325°F %	DRY RESIN CONTENT %
LOT #1	34.5	14.3	51.2	17.9	4.2	34.2
LOT #2	34.0	14.2	51.9	18.0	4.2	34.0
LOT #3	34.1	14.3	51.5	15.6	3.8	34.3
LOT #4	33.9	15.0	51.1	17.2	4.4	35.1
LOT #5	34.1	14.7	51.2	18.9	4.3	34.2
FM	=====					
5055B GRAND AVG.	34.2	14.3	51.5	17.4	4.1	34.2
STD DEV	1.1	0.5	1.5	2.5	0.3	1.1
COUNT	54	54	54	54	54	54
A BASIS FACTOR	2.838	2.838	2.838	2.838	2.838	2.838
A BASIS MINIMUM	31.2	13.0	47.2	10.2	3.2	31.0
A BASIS MAXIMUM	37.2	15.6	55.8	24.5	5.0	37.4

LOT AVERAGES	TACK 50 psi 190°F lbs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500 °C %	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
LOT #1	50	105	1.12	10.4	178	237
LOT #2	40	95	1.10	9.4	177	242
LOT #3	47	50	1.11	9.6	178	235
LOT #4	29	64	1.12	10.0	179	237
LOT #5	31	54	1.13	7.7	179	240
FM	=====					
5055B GRAND AVG.	44	84	1.11	9.7	178	238
STD DEV	12	27	0.02	1.0	1	3
COUNT	54	54	54	52	53	53
A BASIS FACTOR	2.838	2.838	2.838	2.850	2.844	2.844
A BASIS MINIMUM	11	8	1.05	6.9	174	230
A BASIS MAXIMUM	78	159	1.17	12.5	181	247

LOT AVERAGES	-----ATOMIC ABSORPTION-----						PERCENT MOISTURE	PERCENT ASH
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm		
LOT #1	396	21	1	1	0	419	6.62	0.16
LOT #2	381	22	5	5	0	413	4.85	0.20
LOT #3	410	18	2	2	0	432	5.17	0.18
LOT #4	344	16	8	5	0	372	5.23	0.17
LOT #5	249	26	2	4	0	281	6.16	0.13
FM	=====							
5055B GRAND AVG.	387	21	3	3	0	414	5.60	0.18
STD DEV	88	4	2	2	0	88	0.82	0.05
COUNT	53	53	53	53	53	53	53	53
A BASIS FACTOR	2.844	2.844	2.844	2.844	2.844	2.844	2.844	2.844
A BASIS MINIMUM	136	10	-3	-3	0	163	3.26	0.04
A BASIS MAXIMUM	638	31	9	9	0	664	7.94	0.32

FM 5834 UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 150 psi	VOLATILE CONTENT 325°F	DRY RESIN CONTENT
TEST METHOD		CTM-6D	CTM-6D	CTM-6D	PTM-19G	PTM-17B	PTM-16F
#1	D09255-S1	36.8	15.3	47.9	17.9	4.5	41.4
	-S2	35.2	14.6	50.2	18.4	4.6	40.8
#2	D09275-S1	38.1	15.8	46.1	11.9	4.4	38.7
	-S2	35.8	14.9	49.3	19.6	5.5	38.8
	-S3	35.2	14.7	50.1	16.0	5.4	40.8
	-S4	35.9	14.9	49.2	19.4	5.4	37.4
	-S5	38.2	15.9	45.9	19.0	5.4	41.8
	-S6	37.9	15.8	46.4	18.0	5.5	38.6
	-S7	37.6	15.6	46.8	19.7	5.8	42.6
#3	D09233-S1	36.8	15.5	47.8	13.5	4.2	38.8
	-S2	37.3	15.7	47.1	14.0	5.1	39.3
#4	D09314-S1	40.5	17.9	41.6	18.5	4.3	39.0
	-S2	31.6	13.9	54.5	10.6	3.7	31.7
#5	D09336-S1	42.6	18.4	39.0	9.6	4.0	42.4
	-S2	39.7	17.3	43.0	9.4	4.2	42.8
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<u>FM 5834</u>		SOXHLET GRAND TOTAL CONTENT	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	WET FLOW 150 psi	VOLATILE CONTENT 325°F	DRY RESIN CONTENT
		%	%	%	%	%	%
	AVERAGE	37.3	15.7	47.0	15.7	4.8	39.7
	STD DEV	2.6	1.2	3.8	3.9	0.7	2.8
	MINIMUM	31.6	13.9	39.0	9.4	3.7	31.7
	MAXIMUM	42.6	18.4	54.5	19.7	5.8	42.8

FM 5834 UNCURED PREPREG
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 150 psi	VOLATILE CONTENT 325°F	DRY RESIN CONTENT
	%	%	%	%	%	%
LOT #1	36.0	14.9	49.1	18.1	4.5	41.1
LOT #2	36.9	15.4	47.7	17.7	5.3	39.8
LOT #3	37.0	15.6	47.4	13.8	4.7	39.0
LOT #4	36.1	15.9	48.1	14.5	4.0	35.4
LOT #5	41.2	17.9	41.0	9.5	4.1	42.6
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FM 5834 GRAND AVG.	37.3	15.7	47.0	15.7	4.8	39.7
STD DEV	2.6	1.2	3.8	3.9	0.7	2.8
COUNT	15	15	15	15	15	15
<u>A BASIS FACTOR</u>	3.520	3.520	3.520	3.520	3.520	3.520
<u>A BASIS MINIMUM</u>	28.3	11.4	33.7	2.1	2.4	29.8
<u>A BASIS MAXIMUM</u>	46.3	20.1	60.2	29.3	7.2	49.5

FM 5834 UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TACK 50 psi 1bs	GEL 190°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500°C % WT LOSS	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
TEST METHOD		QAI-5070	PTM-20E	CTM-21C	CTM-51	CTM-50A	CTM-50A
#1	D09255-S1	45	165	1.14	7.7	177	239
	-S2	56	169	1.14	7.7	180	240
#2	D09275-S1	60	87	1.08	7.1	182	240
	-S2	44	68	1.09	4.9	182	243
	-S3	36	70	1.09	7.6	182	241
	-S4	40	62	1.07	6.4	182	243
	-S5	48	73	1.07	6.9	181	241
	-S6	35	65	1.05	7.9	183	239
	-S7	42	63	1.08	6.5	180	243
#3	D09233-S1	38	207	1.13	7.9	177	239
	-S2	35	197	1.14	5.7	178	240
#4	D09314-S1	20	67	1.15	6.4	181	240
	-S2	34	58	1.15	8.8	179	240
#5	D09336-S1	26	68	1.03	6.4	179	242
	-S2	39	81	1.03	7.3	182	243

FM 5834	TACK 50 psi 1bs	GEL 190°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500°C % WT LOSS	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
GRAND TOTAL	50 psi 190°F 1bs	TIME 325°F sec	RED IRZB ratio	WT LOSS @ 500°C %	EXOTHERM 1st TEMP °C	EXOTHERM 2nd TEMP °C
AVERAGE	40	100	1.10	7.0	180	241
STD DEV	10	54	0.04	1.0	2	2
MINIMUM	20	58	1.03	4.9	177	239
MAXIMUM	60	207	1.15	8.8	183	243

FM 5834 UNCURED PREPREG
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	TACK 50 psi 1bs	GEL 190°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500°C % WT LOSS	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
LOT #1	51	167	1.14	7.7	179	240
LOT #2	44	70	1.08	6.8	182	241
LOT #3	37	202	1.13	6.8	178	240
LOT #4	27	63	1.15	7.6	180	240
LOT #5	33	75	1.03	6.9	181	243
FM 5834 GRAND AVG.	40	100	1.10	7.0	180	241
STD DEV	10	54	0.04	1.0	2	2
COUNT	15	15	15	15	15	15
<u>A BASIS FACTOR</u>	3.520	3.520	3.520	3.520	3.520	3.520
<u>A BASIS MINIMUM</u>	4	-90	0.95	3.5	173	235
<u>A BASIS MAXIMUM</u>	76	290	1.24	10.5	187	246

FM 5834 UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	ATOMIC ABSORPTION-----						PERCENT MOISTURE	PERCENT ASH
		Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm		
TEST METHOD									
#1	D09255-S1	22	2	33	1	0	58	3.52	0.08
	-S2	18	3	27	2	0	50	3.48	0.07
#2	D09275-S1	8	2	18	2	0	30	3.11	0.04
	-S2	7	2	17	2	0	28	2.85	0.04
	-S3	13	1	16	1	0	31	3.44	0.03
	-S4	6	1	15	1	0	23	2.97	0.04
	-S5	6	2	16	1	0	25	3.13	0.04
	-S6	10	1	35	1	0	47	3.77	0.02
	-S7	5	1	58	2	0	66	2.83	0.04
#3	D09233-S1	12	2	12	1	0	27	2.90	0.03
	-S2	18	2	19	1	0	40	2.84	0.06
#4	D09314-S1	11	3	42	1	0	57	3.30	0.12
	-S2	9	2	148	1	0	160	3.11	0.09
#5	D09336-S1	11	1	27	1	0	40	3.35	0.04
	-S2	16	2	26	1	0	45	3.35	0.10
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<u>FM 5834</u>									
ATOMIC ABSORPTION-----									
GRAND TOTAL		Alkaline Impurities-----						PERCENT MOISTURE	PERCENT ASH
		Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm	%	%
AVERAGE		11	2	34	1	0	48	3.20	0.06
STD DEV		5	1	34	0	0	34	0.29	0.03
MINIMUM		5	1	12	1	0	23	2.83	0.02
MAXIMUM		22	3	148	2	0	160	3.77	0.12

FM 5834 UNCURED PREPREG
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	ATOMIC ABSORPTION-----						PERCENT MOISTURE	PERCENT ASH
	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm		
LOT #1	20	3	30	2	0	54	3.50	0.07
LOT #2	8	1	25	1	0	36	3.16	0.03
LOT #3	15	2	16	1	0	34	2.87	0.04
LOT #4	10	3	95	1	0	109	3.21	0.11
LOT #5	14	2	27	1	0	43	3.35	0.07
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FM 5834 GRAND AVG.	11	2	34	1	0	48	3.20	0.06
STD DEV	5	1	34	0	0	34	0.29	0.03
COUNT	15	15	15	15	15	15	15	15
A BASIS FACTOR	3.520	3.520	3.520	3.520	3.520	3.520	3.520	3.520
A BASIS MINIMUM	-6	-1	-85	0	0	-70	2.17	-0.05
A BASIS MAXIMUM	29	4	153	3	0	167	4.22	0.16

FM 5064J UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 150 psi	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
<u>HITCO 150psi</u>							
	TEST METHOD	CTM-6D	CTM-6D	CTM-6D	PTM-19G	PTM-17B	PTM-16F
#1(H)	C02134-S1	35.3	14.5	50.2	14.4	3.4	33.8
	-E1	34.6	14.2	51.2	10.9	3.0	33.6
	-S2	34.5	14.2	51.4	10.5	2.9	33.9
	-E2	35.1	14.4	50.5	14.0	3.1	35.0
#2(H)	D09279-S1	34.7	14.2	51.1	15.0	3.5	35.2
#3(H)	C02137-S1	33.7	13.8	52.5	11.5	2.9	34.2
#4(H)	D09315-S1	33.5	14.2	52.3	9.1	3.1	33.3
	-E1	33.3	14.1	52.6	12.2	3.2	35.0
#5(H)	D09337-S1	33.3	14.7	52.0	11.2	3.3	34.0
	-S2	34.0	15.0	51.0	12.6	3.3	35.2
<u>KAISER 1000psi</u>							
					1000 psi		
#1(K)	C02135-S1	32.6	13.4	54.0	13.9	2.3	34.4
#2(K)	D09280-S1	32.7	13.4	53.8	18.0	2.7	33.6
	-E1	34.2	14.0	51.8	17.5	2.6	35.2
	-S2	33.9	13.9	52.2	17.1	2.5	35.3
	-E2	34.4	14.1	51.5	16.6	2.5	35.0
	-S3	33.1	13.6	53.3	17.3	2.5	34.3
	-E3	33.3	13.7	53.0	15.6	2.4	33.4
#3(K)	C02138-S1	33.3	13.6	53.1	14.9	2.0	34.2
#4(K)	D09316-S1	32.5	14.3	53.2	17.9	2.8	33.5
	-E1	31.5	13.8	54.7	17.8	2.8	32.6
<hr/>							
<u>FM 5064J</u>							
	GRAND TOTAL	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
		%	%	%	%	%	%
	AVERAGE	33.7	14.1	52.3	--	2.8	34.2
	STD DEV	1.0	0.4	1.2	--	0.4	0.8
	MINIMUM	31.5	13.4	50.2	--	2.0	32.6
	MAXIMUM	35.3	15.0	54.7	--	3.5	35.3
					150 psi (HITCO)		
<u>HITCO AVERAGE</u>							
	STD DEV	0.7	0.3	0.8	1.9	0.2	0.7
						1000 psi (KAISER)	
<u>KAISER AVERAGE</u>							
	STD DEV	0.9	0.3	1.0	1.4	0.2	0.9

FM 5064J UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TACK 50 psi 190°F 1lbs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500°C %	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
<u>HITCO 150psi</u>							
	TEST METHOD	QAI-5070	PTM-20E	CTM-21C	CTM-51	CTM-50A	CTM-50A
#1(H)	C02134-S1	55	96	0.82	7.9	181	
	-E1	50	84	0.76	6.6	183	
	-S2	35	69	0.81	6.4	183	
	-E2	58	64	0.83	10.5	182	
#2(H)	D09279-S1	25	91	0.82	8.8	184	
#3(H)	C02137-S1	30	46	0.82	10.1	182	
#4(H)	D09315-S1	30	69	0.82	10.5	184	
	-E1	30	75	0.77	10.9	185	
#5(H)	D09337-S1	31	72	0.92	10.3	183	
	-S2	29	78	0.82	9.9	183	
<u>KAISER 1000psi</u>							
#1(K)	C02135-S1	26	34	0.82	8.9	182	
#2(K)	D09280-S1	46	75	0.83	8.7	183	
	-E1	40	61	0.82	9.3	184	
	-S2	36	58	0.81	9.2	184	
	-E2	26	87	0.80	9.3	185	
	-S3	30	78	0.78	8.6	184	
	-E3	24	54	0.77	9.8	183	
#3(K)	C02138-S1	15	54	0.82	9.2	180	
#4(K)	D09316-S1	38	78	0.83	10.7	185	
	-E1	42	83	0.82	10.7	184	
<hr/>							
<u>FM 5064J</u>							
GRAND TOTAL	TACK 50 psi 190°F 1lbs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. @ 500 °C %	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C	
AVERAGE	35	70	0.81	9.3	183		
STD DEV	11	16	0.03	1.3	1		
MINIMUM	15	34	0.76	6.4	180		
MAXIMUM	58	96	0.92	10.9	185		
<u>HITCO AVERAGE</u>	37	74	0.82	9.2	183		
STD DEV	12	14	0.04	1.7	1		
<u>KAISER AVERAGE</u>	32	66	0.81	9.4	183		
STD DEV	10	17	0.02	0.7	2		

FM 5064J UNCURED PREPREG DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO. <u>HITCO 150psi</u>	LOT and SAMPLE TEST METHOD	ATOMIC ABSORPTION-----						PERCENT MOISTURE %	PERCENT ASH %
		Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm		
-----CTM-53B-----									
#1(H) CO2134-S1		4	0	1	3	0	8	2.11	0.20
	-E1	3	0	1	2	0	6	2.08	0.20
	-S2	4	0	1	1	0	6	1.96	0.08
	-E2	7	1	0	1	0	9	1.90	0.22
#2(H) D09279-S1		7	0	11	2	0	20	2.17	0.06
#3(H) CO2137-S1		5	0	0	3	0	8	2.04	0.25
#4(H) D09315-S1		24	1	10	2	0	37	2.25	0.03
	-E1	26	2	10	2	0	40	2.31	0.09
#5(H) D09337-S1		12	1	4	1	0	18	2.44	0.01
	-S2	15	1	2	1	0	19	2.20	0.00
<u>KAISER 1000psi</u>									
#1(K) CO2135-S1		1	0	0	3	0	4	1.76	0.16
#2(K) D09280-S1		6	0	7	1	0	14	1.93	0.03
	-E1	7	1	9	2	0	19	2.03	0.05
	-S2	6	1	7	1	0	15	1.99	0.08
	-E2	8	1	13	2	0	24	1.92	0.02
	-S3	7	1	8	2	0	18	1.89	0.03
	-E3	6	1	12	2	0	21	1.78	0.06
#3(K) CO2138-S1		5	0	0	6	0	11	1.76	0.22
#4(K) D09316-S1		25	2	10	2	0	39	2.39	0.09
	-E1	25	2	5	2	0	34	1.94	0.09
<hr/>									
FM 5064J									
GRAND		ATOMIC ABSORPTION-----						PERCENT	
TOTAL		Alkaline Impurities-----						PERCENT	
		Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm	%	ASH %
AVERAGE		10	1	6	2	0	19	2.04	0.10
STD DEV		8	1	5	1	0	11	0.20	0.08
MINIMUM		1	0	0	1	0	4	1.76	0.00
MAXIMUM		26	2	13	6	0	40	2.44	0.25
HITCO AVERAGE		11	1	4	2	0	17	2.15	0.11
STD DEV		8	1	5	1	0	13	0.16	0.10
KAISER AVERAGE		10	1	7	2	0	20	1.94	0.08
STD DEV		8	1	4	1	0	10	0.19	0.06

FM 5064J UNCURED PREPREG
 LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES for LARGE LOTS	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW	VOLATILE CONTENT 325°F	DRY RESIN CONTENT
HITCO #1 C02134	34.9	14.3	50.8	12.5	3.1	34.0
HITCO #4 D09315	33.4	14.2	52.4	10.6	3.1	34.2
HITCO #5 D09337	33.7	14.9	51.5	11.9	3.3	34.6
KAISER #2 D09280	33.6	13.8	52.6	17.0	2.5	34.5
KAISER #4 D09316	32.0	14.1	54.0	17.8	2.8	33.1
5064J GRAND AVG.	33.7	14.1	52.3	[A BASIS HITCO]		34.2
STD DEV	1.0	0.4	1.2	MIN 4.7	MIN 2.3	0.8
COUNT	20	20	20	MAX 19.6	MAX 4.0	20
A BASIS FACTOR	3.295	3.295	3.295	[A BASIS KAISER]		3.295
A BASIS MINIMUM	30.5	12.7	48.3	MIN 11.1	MIN 1.5	31.7
A BASIS MAXIMUM	36.8	15.4	56.3	MAX 22.2	MAX 3.5	36.8
				[FACTOR 3.981]		

LOT AVERAGES for LARGE LOTS	TACK 50 psi 190°F lbs	GEL TIME 325°F sec	INFRA- RED IRZB ratio	T.G.A. WT LOSS @ 500°C %	DSC EXOTHERM 1st TEMP °C	DSC EXOTHERM 2nd TEMP °C
HITCO #1 C02134	50	78	0.80	7.9	182	
HITCO #4 D09315	30	72	0.80	10.7	185	
HITCO #5 D09337	30	75	0.87	10.1	183	
KAISER #2 D09280	34	69	0.80	9.2	184	
KAISER #4 D09316	40	81	0.82	10.7	185	
5064J GRAND AVG.	35	70	0.81	9.3	183	
STD DEV	11	16	0.03	1.3	1	
COUNT	20	20	20	20	20	
A BASIS FACTOR	3.295	3.295	3.295	3.295	3.295	
A BASIS MINIMUM	-1	19	0.71	5.1	179	
A BASIS MAXIMUM	71	122	0.92	13.5	188	

LOT AVERAGES for LARGE LOTS	-----ATOMIC ABSORPTION-----						PERCENT MOISTURE	PERCENT ASH	
	-----Alkaline Impurities-----								
Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL				
HITCO #1 C02134	5	0	1	2	0	7	2.01	0.17	
HITCO #4 D09315	25	2	10	2	0	39	2.28	0.06	
HITCO #5 D09337	14	1	3	1	0	19	2.32	0.01	
KAISER #2 D09280	7	1	9	2	0	19	1.92	0.04	
KAISER #4 D09316	25	2	8	2	0	37	2.17	0.09	
5064J GRAND AVG.	10	1	6	2	0	19	2.04	0.10	
STD DEV	8	1	5	1	0	11	0.20	0.08	
COUNT	20	20	20	20	20	20	20	20	
A BASIS FACTOR	3.295	3.295	3.295	3.295	3.295	3.295	3.295	3.295	
A BASIS MINIMUM	-17	-2	-10	-2	0	-19	1.38	-0.17	
A BASIS MAXIMUM	37	3	21	6	0	56	2.70	0.36	

FM 5839 UNCURED PREPREG DATA
AVERAGE TEST RESULTS

Page #23

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 1000 psi	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
TEST METHOD		CTM-6D	CTM-6D	CTM-6D	PTM-19G	PTM-17B	PTM-16F
#1	C02136-S1	34.5	14.2	51.3	14.8	2.2	34.9
	-S2	32.5	13.3	54.2	10.3	2.2	33.9
#2	D09318-S1	33.0	13.5	53.6	13.2	3.2	35.1
	-S2	34.4	14.1	51.5	12.7	2.5	41.3
#3	C02139-S1	35.2	14.4	50.5	17.4	2.4	34.4
	-S2	36.8	15.0	48.1	13.2	2.8	36.0
#4	D09317-S1	35.2	15.0	49.8	11.0	2.4	35.9
	-S2	35.7	15.2	49.1	17.8	2.4	37.5
	-S3	33.5	14.2	52.3	11.0	2.4	34.2
	-S4	29.0	12.3	58.7	9.5	2.3	30.3
	-S5	34.5	14.7	50.8	18.8	2.6	38.4
	-S6	36.2	15.4	48.4	16.1	2.7	36.4
#5	D09338-S1	33.7	14.9	51.4	9.0	2.2	37.3
	-S2	34.2	15.1	50.8	8.6	2.2	34.6
<hr/>							
<u>FM 5839</u>		SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 1000 psi	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
GRAND TOTAL		%	%	%	%	%	%
AVERAGE		34.2	14.4	51.5	13.1	2.5	35.7
STD DEV		1.9	0.9	2.7	3.4	0.3	2.5
MINIMUM		29.0	12.3	48.1	8.6	2.2	30.3
MAXIMUM		36.8	15.4	58.7	18.8	3.2	41.3
LOT							
#2	D09281 S1	42.9	17.6	39.5	31.1	2.9	31.7
REJECT	S2	41.8	17.2	41.0	35.5	3.4	41.6
AVERAGE		42.4	17.4	40.3	33.3	3.2	36.7

FM 5839 UNCURED PREPREG
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	SOXHLET RESIN CONTENT	SOXHLET FILLER CONTENT	SOXHLET CLOTH CONTENT	WET FLOW 1000 psi	VOLATILE CONTENT 325 °F	DRY RESIN CONTENT
	%	%	%	%	%	%
LOT #1	33.5	13.7	52.8	12.6	2.2	34.4
LOT #2	33.7	13.8	52.5	13.0	2.9	38.2
LOT #3	36.0	14.7	49.3	15.3	2.6	35.2
LOT #4	34.0	14.4	51.5	14.0	2.5	35.4
LOT #5	34.0	15.0	51.1	8.8	2.2	36.0
<hr/>						
FM 5839 GRAND AVG.	34.2	14.4	51.5	13.1	2.5	35.7
STD DEV	1.9	0.9	2.7	3.4	0.3	2.5
COUNT	14	14	14	14	14	14
A BASIS FACTOR	3.585	3.585	3.585	3.585	3.585	3.585
A BASIS MINIMUM	27.3	11.3	41.7	0.8	1.4	26.6
A BASIS MAXIMUM	41.1	17.4	61.2	25.4	3.5	44.9

(NOTE: TOTALS DO NOT INCLUDE LOT #2 REJECT)

FM 5839 UNCURED PREPREG DATA
AVERAGE TEST RESULTS

PAGE # 24

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TACK	GEL	INFRA-	T.G.A.	DSC	DSC
		50 psi 190°F 1bs	TIME 325°F sec	RED IRZB ratio	WT LOSS @ 500°C %	EXOTHERM 1st TEMP °C	EXOTHERM 2nd TEMP °C
	TEST METHOD	QAI-5070	PTM-20E	CTM-21C	CTM-51	CTM-50A	CTM-50A
#1	C02136-S1	38	44	0.85	8.0	184	
	-S2	35	43	0.85	8.8	183	
#2	D09318-S1	15	79	0.81	7.5	186	
	-S2	20	83	0.81	9.4	186	
#3	C02139-S1	30	32	0.85	8.9	183	
	-S2	32	39	0.85	9.1	184	
#4	D09317-S1	11	87	0.81	9.4	184	
	-S2	16	97	0.80	11.9	184	
	-S3	10	82	0.81	8.9	184	
	-S4	9	58	0.80	9.0	185	
	-S5	12	82	0.81	8.6	185	
	-S6	13	84	0.79	10.0	185	
	#5 D09338-S1	11	86	0.84	8.9	184	
	-S2	8	59	0.87	9.5	183	
<hr/>							
<u>FM 5839</u>		TACK	GEL	INFRA-	T.G.A.	DSC	DSC
GRAND		50 psi	TIME	RED	WT LOSS	EXOTHERM	EXOTHERM
TOTAL		190°F	325°F	IRZB	@ 500°C	1st TEMP	2nd TEMP
		1bs	sec	ratio	%	°C	°C
AVERAGE		19	68	0.82	9.1	184	
STD DEV		11	22	0.02	1.0	1	
MINIMUM		8	32	0.79	7.5	183	
MAXIMUM		38	97	0.87	11.9	186	
LOT							
#2 D09281 S1		26	48	0.78	14.2	185	
REJECT S2		29	51	0.81	12.6	185	
AVERAGE		28	50	0.79	13.4	185	

FM 5839 UNCURED PREPREG
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	TACK	GEL	INFRA-	T.G.A.	DSC	DSC
	50 psi 190°F 1bs	TIME 325°F sec	RED IRZB ratio	WT LOSS @ 500°C %	EXOTHERM 1st TEMP °C	EXOTHERM 2nd TEMP °C
LOT #1	37	44	0.85	8.4	184	
LOT #2	18	81	0.81	8.5	186	
LOT #3	31	36	0.85	9.0	184	
LOT #4	12	82	0.80	9.6	185	
LOT #5	10	73	0.85	9.2	184	
<hr/>						
FM 5839 GRAND AVG.	19	68	0.82	9.1	184	
STD DEV	11	22	0.02	1.0	1	
COUNT	14	14	14	14	14	
A BASIS FACTOR	3.585	3.585	3.585	3.585	3.585	
A BASIS MINIMUM	-19	-9	0.73	5.5	181	
A BASIS MAXIMUM	56	145	0.91	12.7	188	

(NOTE: TOTALS DO NOT INCLUDE LOT #2 REJECT)

FM 5839 UNCURED PREPREG DATA
AVERAGE TEST RESULTS

Page #25

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	ATOMIC ABSORPTION						PERCENT MOISTURE	PERCENT ASH	
		Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm			
		TEST METHOD								
								CTM-53B		
#1	C02136-S1	5	1	13	2	0	21	1.82	0.16	
	-S2	8	3	5	2	0	18	1.85	0.23	
#2	D09318-S1	8	1	27	1	0	37	2.14	0.06	
	-S2	10	2	26	2	0	40	2.17	0.06	
#3	C02139-S1	7	1	34	2	0	44	1.84	0.24	
	-S2	8	1	19	8	0	36	2.04	0.27	
#4	D09317-S1	31	2	17	1	0	51	1.95	0.01	
	-S2	36	4	14	3	0	57	2.33	0.04	
	-S3	29	2	22	1	0	54	2.03	0.03	
	-S4	29	2	21	1	0	53	4.48	0.05	
	-S5	30	3	19	1	0	53	2.13	0.08	
	-S6	33	2	25	1	0	61	2.61	0.07	
#5	D09338-S1	20	2	10	2	0	34	1.99	0.05	
	-S2	21	3	11	2	0	37	2.13	0.05	

FM 5839	ATOMIC ABSORPTION								PERCENT ASH
	Alkaline Impurities						PERCENT MOISTURE		
GRAND TOTAL	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm			
AVERAGE	20	2	19	2	0	43	2.25	0.10	
STD DEV	12	1	8	2	0	13	0.68	0.09	
MINIMUM	5	1	5	1	0	18	1.82	0.01	
MAXIMUM	36	4	34	8	0	61	4.48	0.27	
LOT									
#2	D09281 S1	8	1	49	2	0	60	2.45	0.05
REJECT	S2	8	1	44	2	0	55	2.68	0.06
AVERAGE	8	1	47	2	0	58	2.57	0.06	

FM 5839 UNCURED PREPREG
LOT AVERAGES AND STATISTICAL SUMMARY

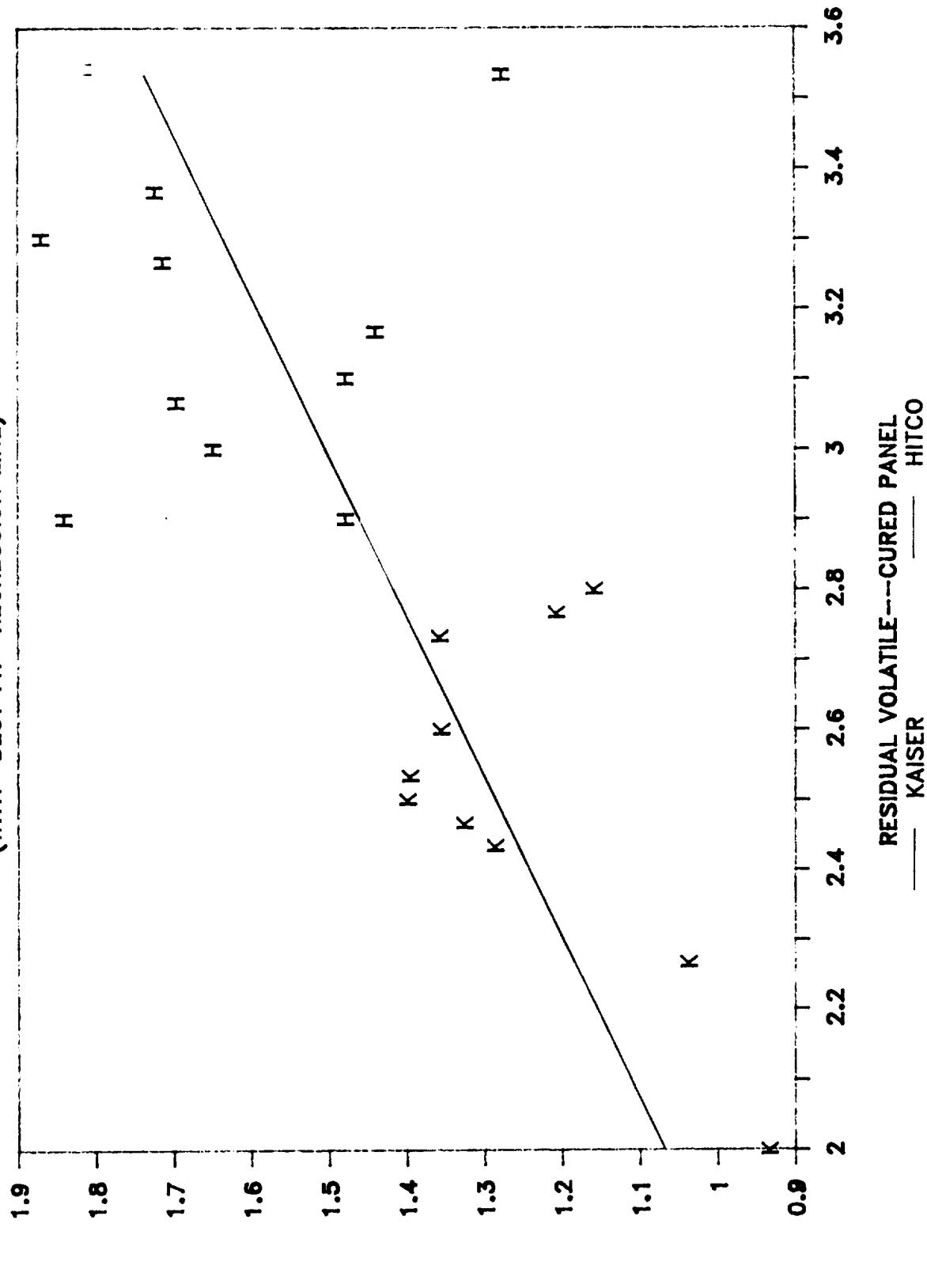
NAS8-36298

LOT	ATOMIC ABSORPTION								PERCENT ASH
	Alkaline Impurities						PERCENT MOISTURE		
LOT AVERAGES	Na ppm	K ppm	Ca ppm	Mg ppm	Li ppm	TOTAL ppm			
LOT #1	7	2	9	2	0	20	1.84	0.20	
LOT #2	9	2	27	2	0	39	2.15	0.06	
LOT #3	8	1	27	5	0	40	1.94	0.25	
LOT #4	31	3	20	1	0	55	2.59	0.04	
LOT #5	21	3	11	2	0	36	2.06	0.05	
FM									
5839 GRAND AVG.	20	2	19	2	0	43	2.25	0.10	
STD DEV	12	1	8	2	0	13	0.68	0.09	
COUNT	14	14	14	14	14	14	14	14	
A BASIS FACTOR	3.585	3.585	3.585	3.585	3.585	3.585	3.585	3.585	
A BASIS MINIMUM	-22	-1	-9	-4	0	-4	-0.17	-0.21	
A BASIS MAXIMUM	61	5	47	9	0	89	4.67	0.41	

(NOTE: TOTALS DO NOT INCLUDE LOT #2 REJECT)

FM 5064J VOLATILE COMPARISONS

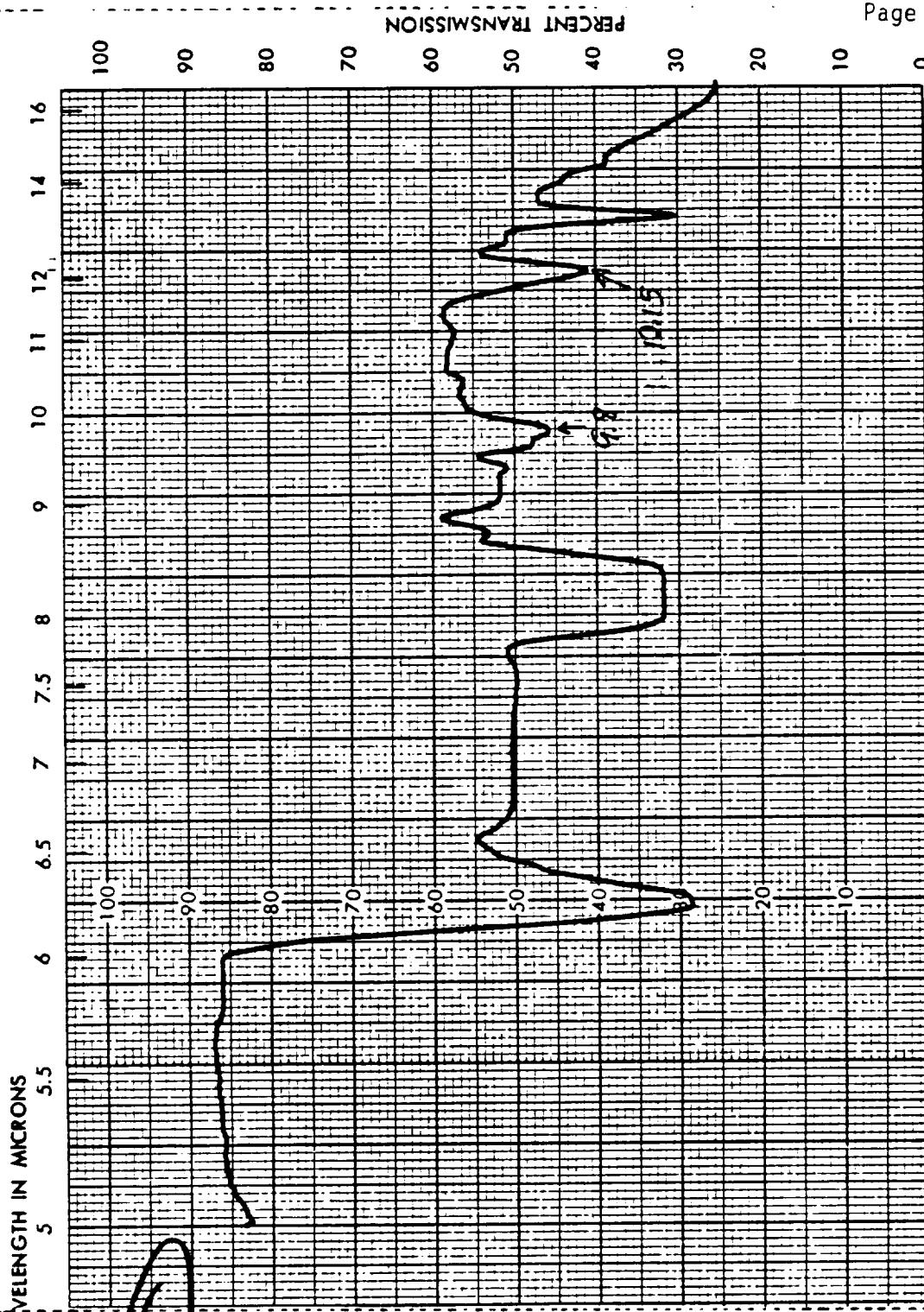
(WITH "BEST FIT" REGRESSION LINE)



WAVENUMBER CM⁻¹

2000 1800 1600 1400 1200 1000 800

600



SPECTRUM NO. 15226
 DATE 7-09-84
 SAMPLE FM 5055 D
DE 9254 3E

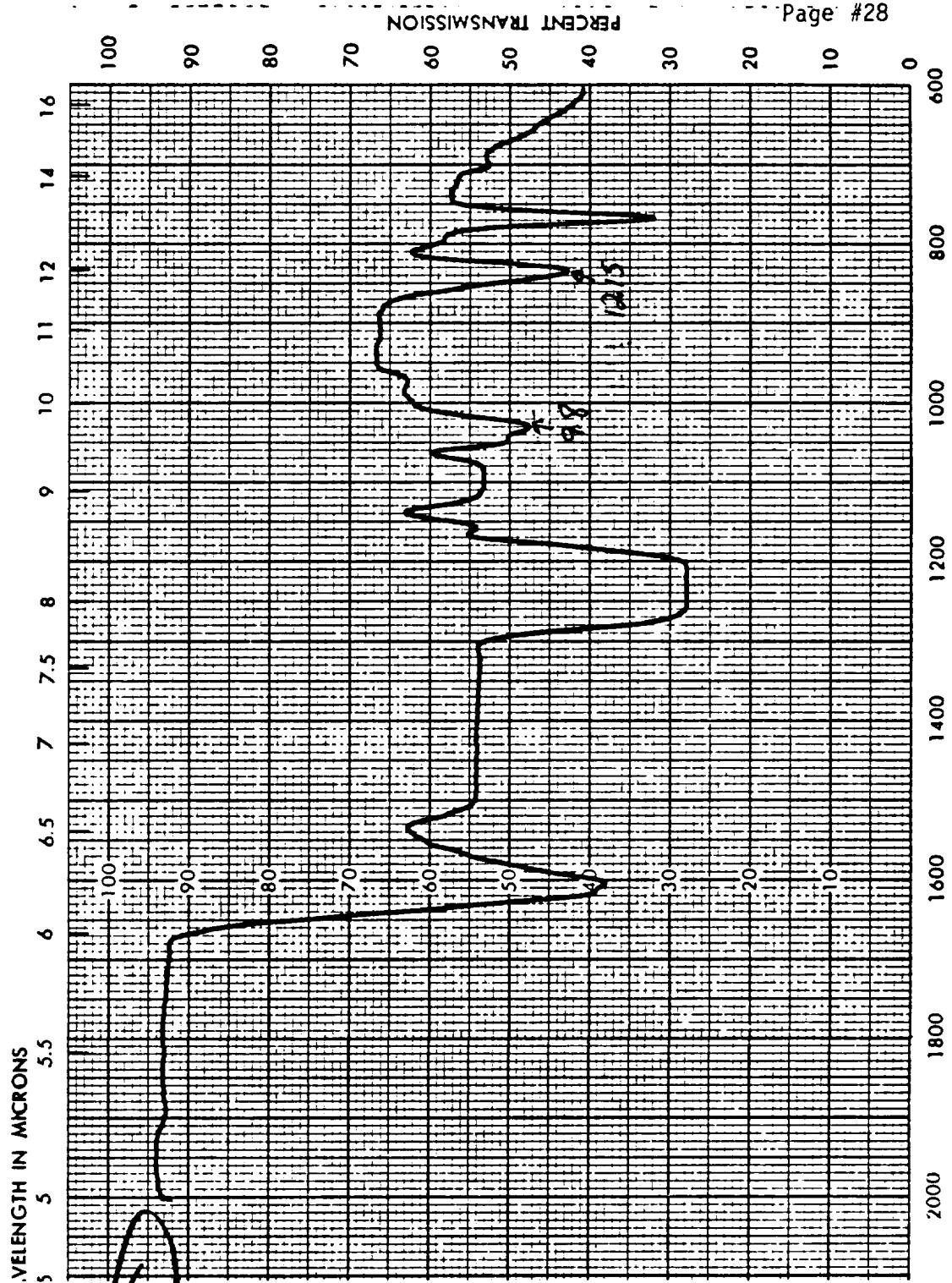
SOURCE _____
 STRUCTURE _____

PATH 0.2 mm KBr
 SOLVENT ACETONE
 CONCENTRATION 30 - 50 %
 PHASE 3
 COMMENTS VAP - PREC.
MATERIAL

ANALYST V. MIRANDA

Beckman
INFRARED
SPECTROPHOTOMETER

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SPECTRUM NO. 15205
 DATE 7-08-84
 SAMPLE FM 5834
D9255 H 31

SOURCE _____
 STRUCTURE _____

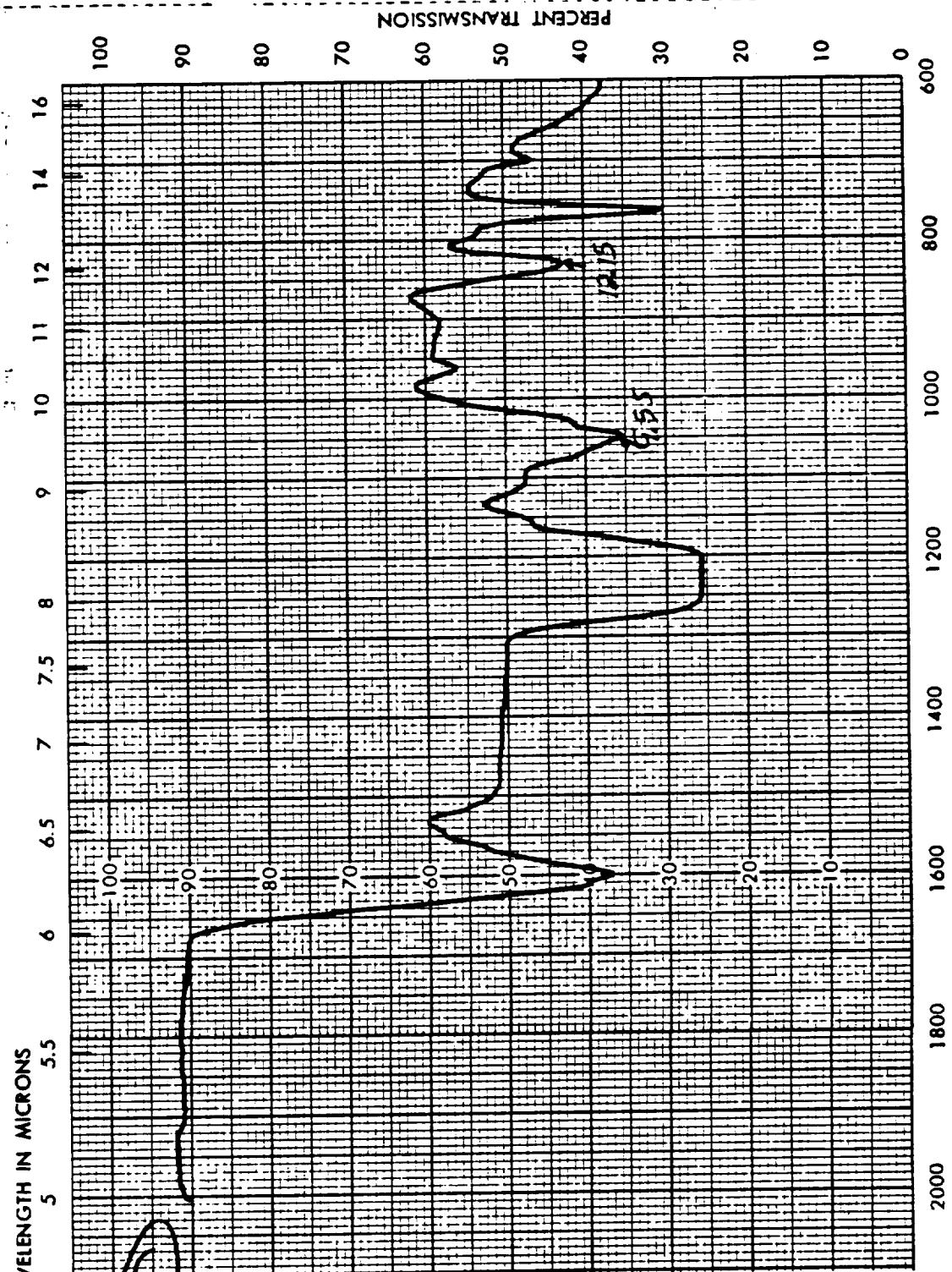
PATH 0.2 mm NACL
 SOLVENT ACETONE
 CONCENTRATION 80 - 50 %t
 PHASE S
 COMMENTS PRE-REGEN
MATERIAL

ANALYST V. MIRANDA

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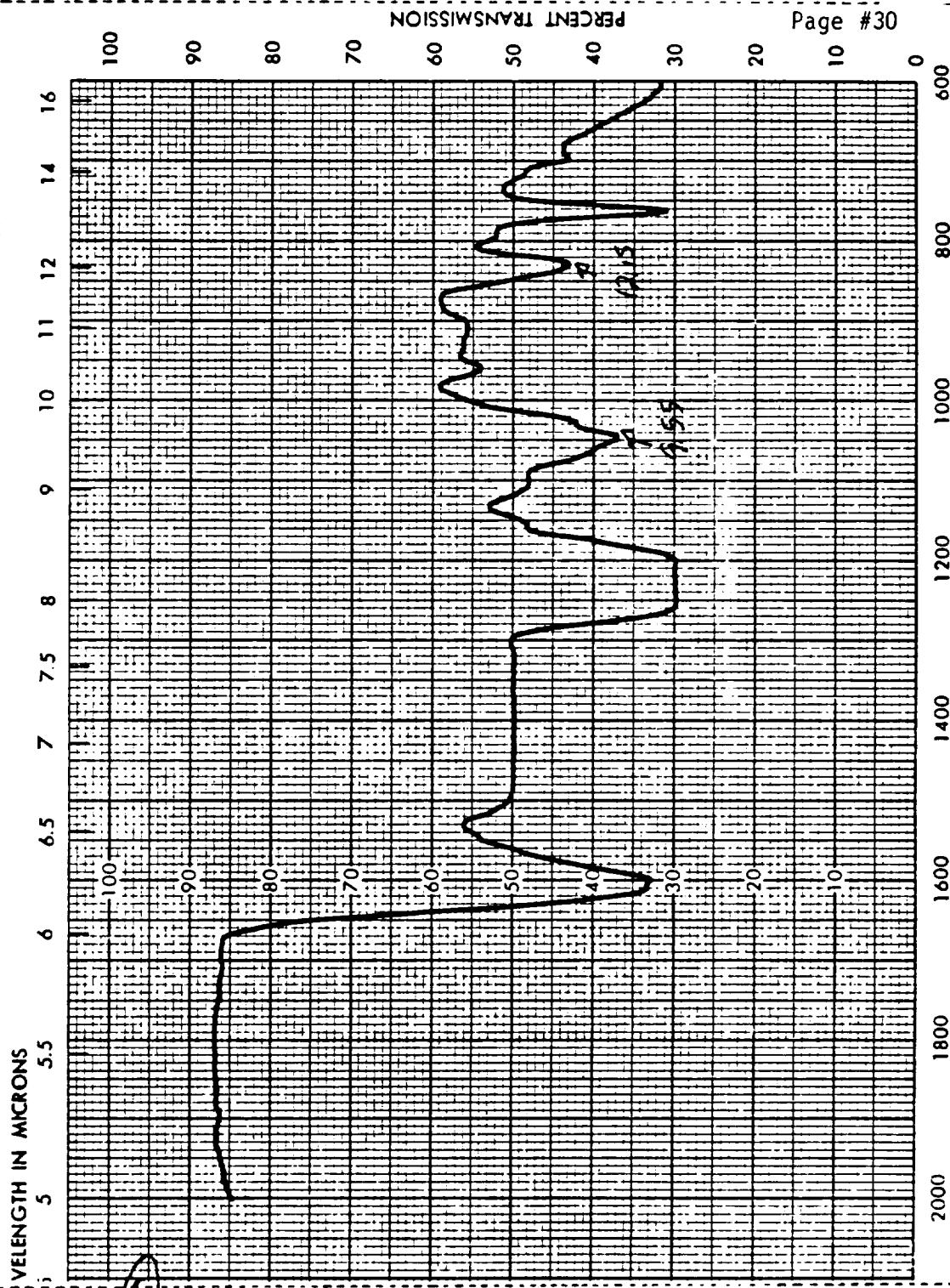
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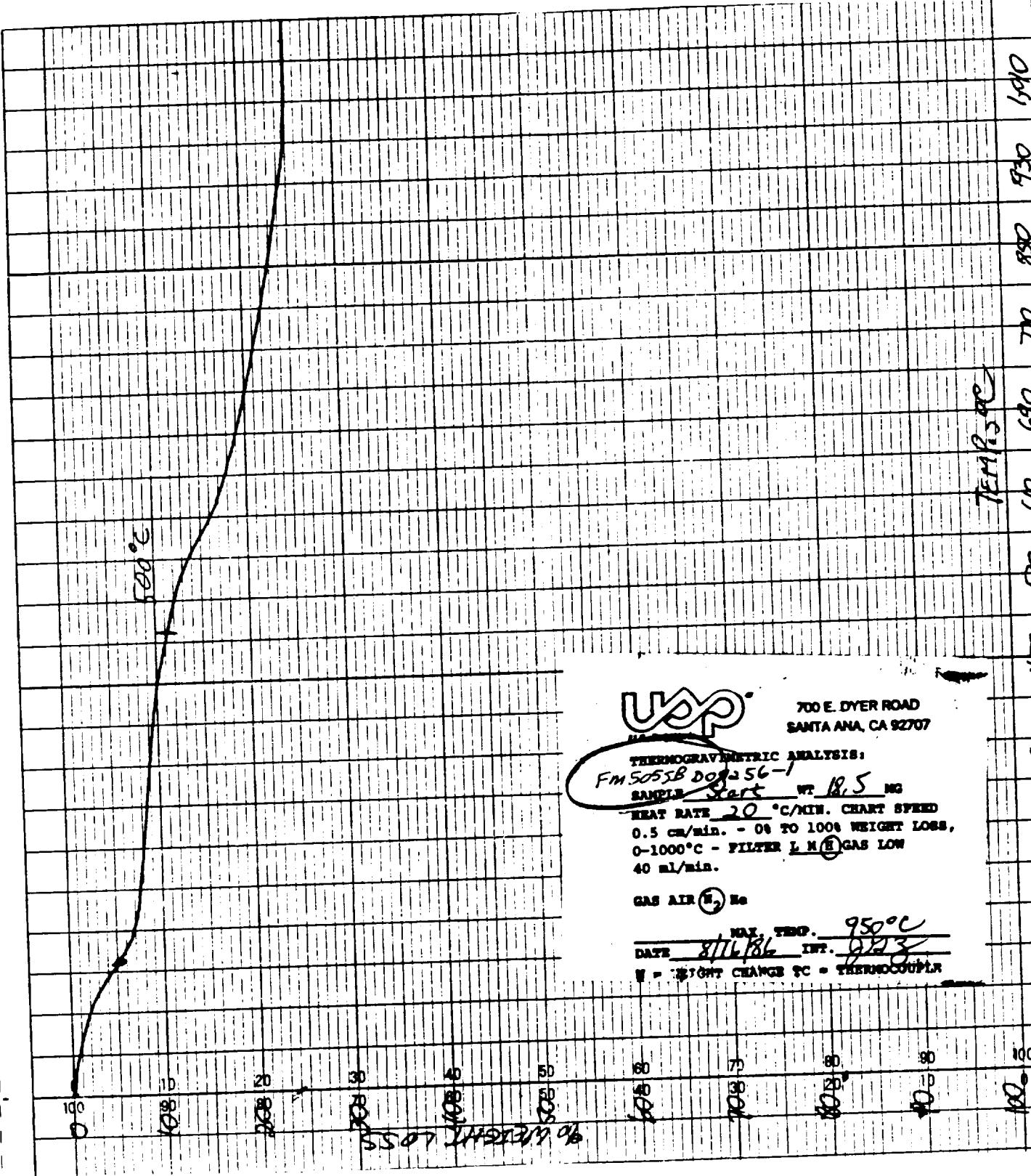
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 DATE 7-26-86
 SAMPLE FM 5039
CD 2134 # ST-1

SOURCE _____
 STRUCTURE _____

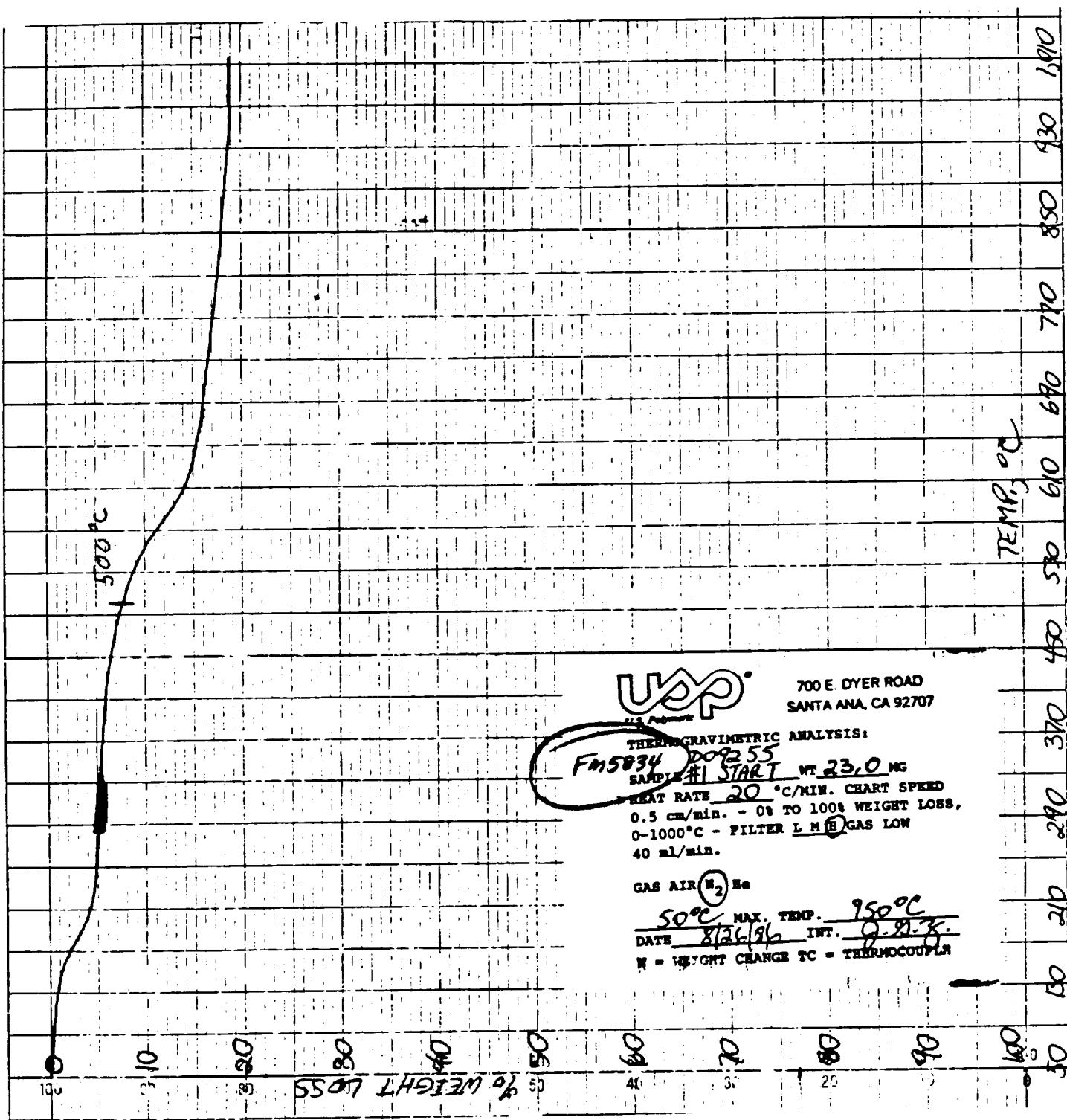
PATH 0.2 mm NaCl
 SOLVENT ACETONE
 CONCENTRATION 30-50%
 PHASE 3
 COMMENTS PRE-PREG
 MATERIAL _____

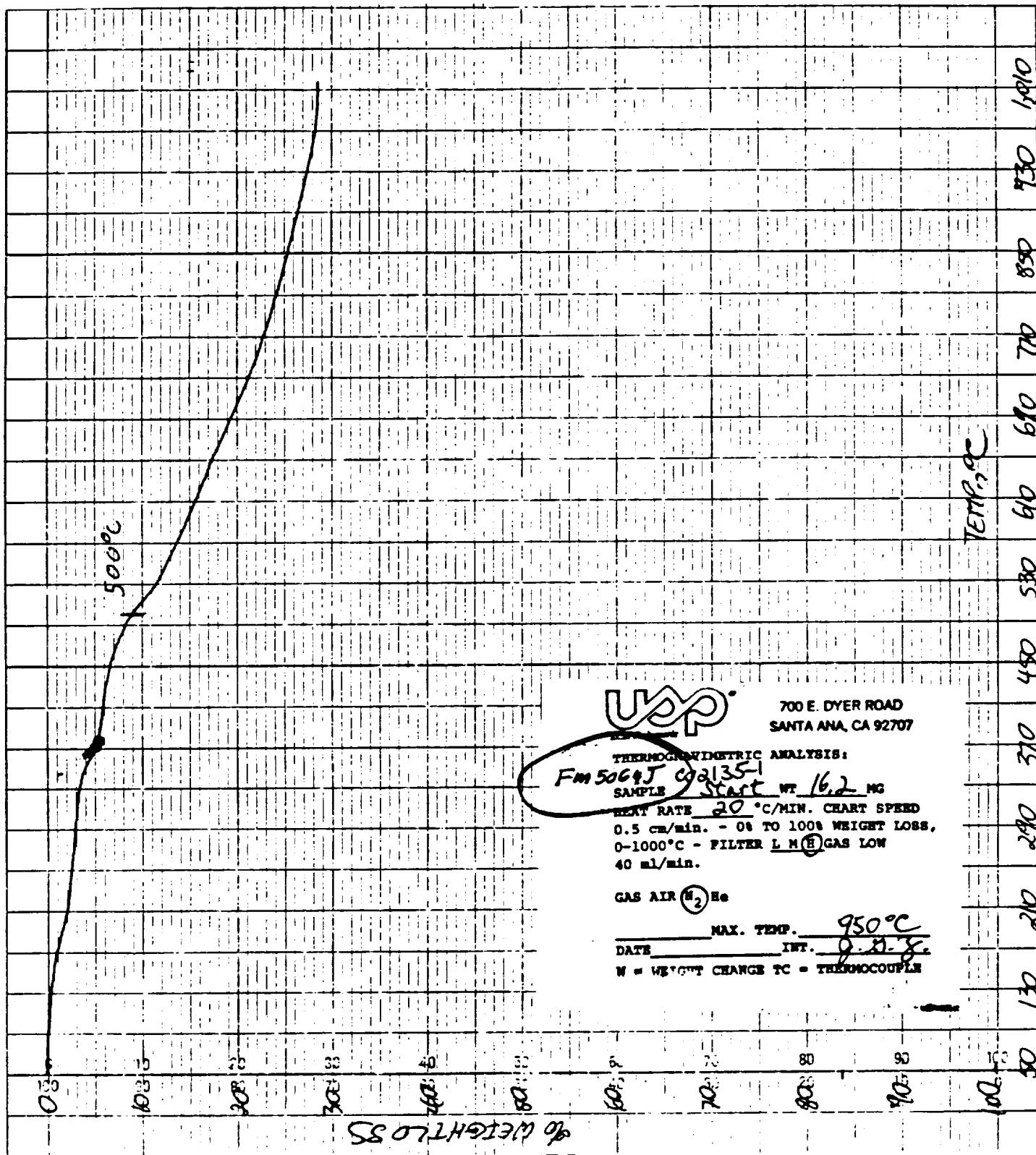
ANALYST Y. MIRANDA

Beckman
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SPECTROPHOTOMETER

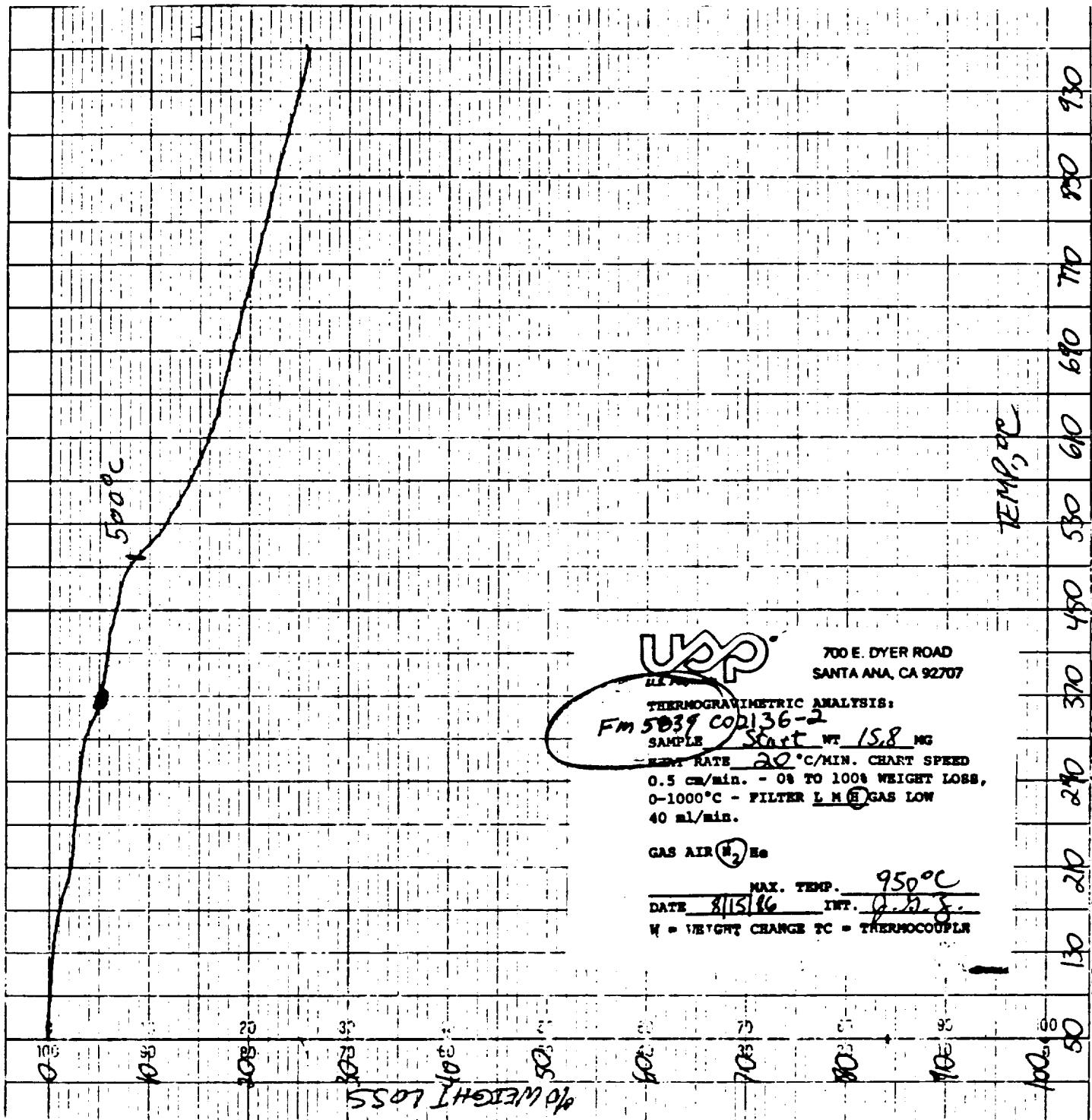


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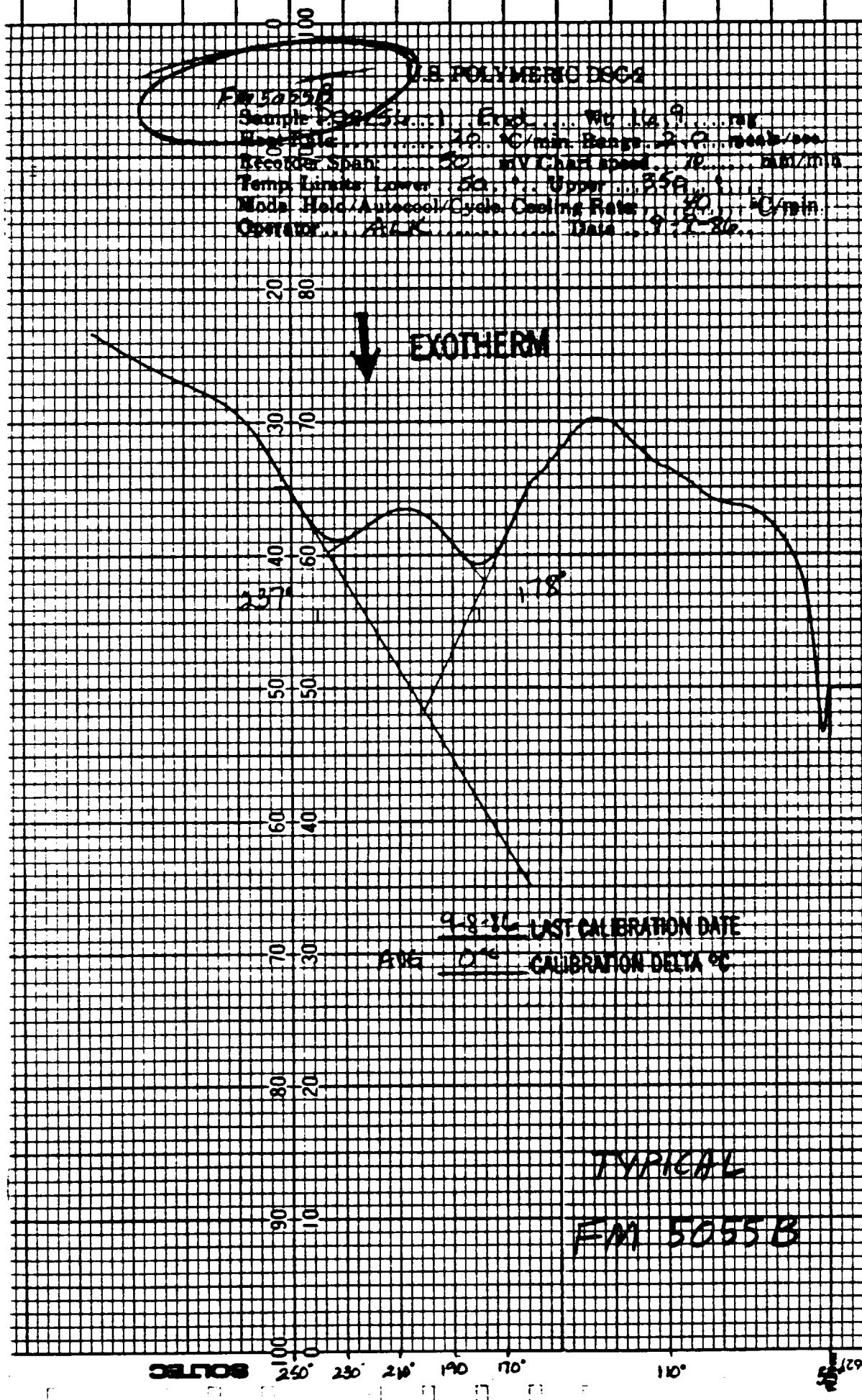


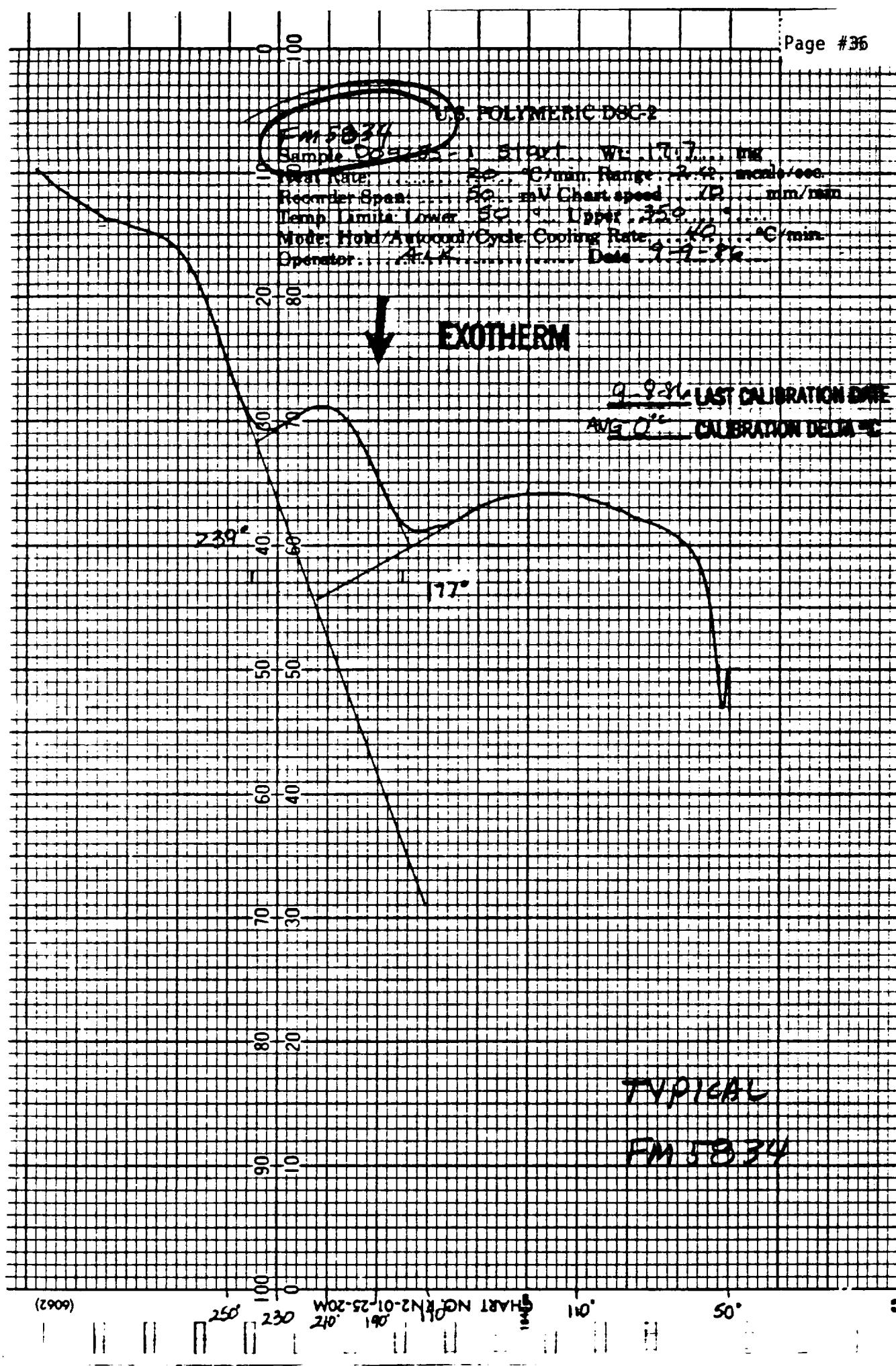


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~~EMI 52641 S-1010-1000-1000-1000~~

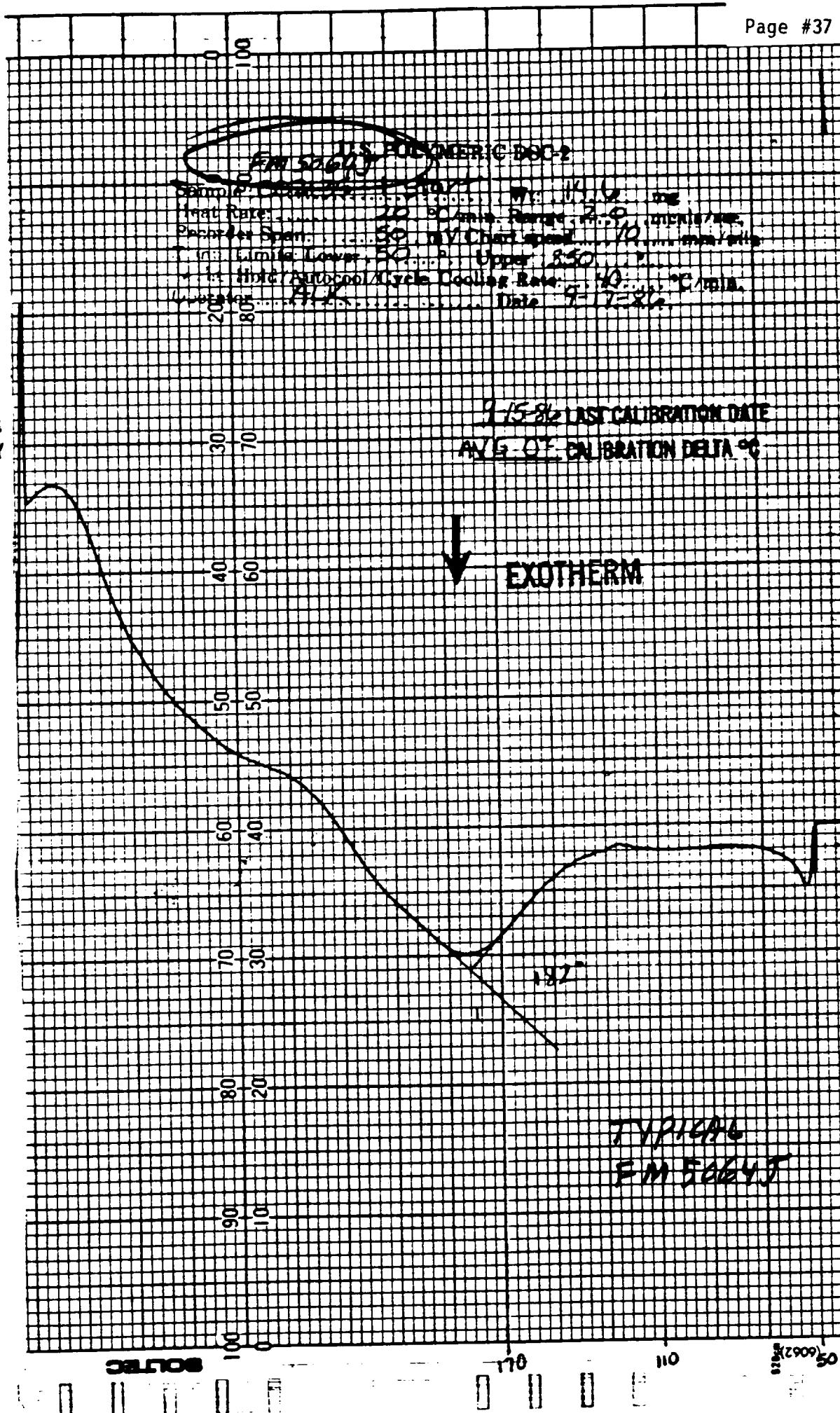
Sample 100% 100% 100% 100% 100%
Heat Rate: 25.0 W/min. P= 2.5 min/min
Polarized Span: 50 mV Ch1, 100 mV Ch2
Min. Limit Lower: 50 Upper: 850
Hot Autocool/Cycle Cooling Rate: 40 °C/min.
Date: 7-25-85, 12:55 PM Data: 7-7-85.

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7-15-86 LAST CALIBRATION DATE
AVG. OF CALIBRATION DELTA %

EXOTHERM

TYPICAL
EMI 52641



U.S. POLYMERIC DISC 2

F.M. 5839
 Sample: DSC 2 Start Wt. 12 mg 50
 Heat Rate: 20 °C/min Range 200 mcal/sec
 Recorder Spn: 50 mV Chart speed 10 mm/min
 Temp. Limits: Lower 50 Upper 350
 Mode: Hold/Autocool/Cycle Cooling Rate: 40 °C/min
 Operator: A.K. Date: 9/2/86

20

80

7-15-86 LAST CALIBRATION DATE

FIG C° CALIBRATION DELTA °C

EXOTHERM

40

60

50

50

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60

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30

20

20

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40

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60

70

80

90

100

FURNACE

F.M. 5839

CHART NO. RN2-01-2

SOLTEC

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TABLE OF CONTENTS

CURED PANEL TESTING

NAS8-36298

U.S. Polymeric O.E. 71108

	<u>PAGE</u>
I. SAMPLING PLAN.....	1
II. TEST METHODS AND OBSERVATIONS.....	2
A. Tensile Strength, Modulus and Elongation.....	2
B. Compressive Strength and Modulus.....	3
C. Flexural Strength and Modulus.....	3
D. Specific Gravity.....	3
E. Double Shear Strength.....	4
F. Barcol Hardness.....	4
G. Residual Volatiles.....	4
H. Resin Content by Pyrolysis.....	5
I. Acetone Extraction.....	5
J. Coefficient of Thermal Expansion (CTE).....	6
III. SUMMARY.....	6

TABLES AND CHARTS

Comparative Cured Panel Data.....	8
FM 5055B Test Results.....	11
FM 5055B Statistical Summary.....	14

	<u>PAGE</u>
FM 5834 Test Results and Statistical Summary.....	15
FM 5064J Test Results.....	18
FM 5064J Statistical Summary.....	21
FM 5839 Test Results and Statistical Summary.....	22
Typical CTE Curves.....	25

	<u>PAGE</u>
FM 5834 Test Results and Statistical Summary.....	15
FM 5064J Test Results.....	18
FM 5064J Statistical Summary.....	21
FM 5839 Test Results and Statistical Summary.....	22
Typical CTE Curves.....	25

CURED PANEL TESTING

COMMENTS AND OBSERVATION

NAS8-36298

I. SAMPLING PLAN

For the rayon-based fabrics, the resultant prepgs, FM 5055B and FM 5064J, had 10 yards samples taken from the start and the end of each 100-pound prepreg roll. For the spun PAN fabrics, FM 5834 and FM 5839 prepgs were run to nominal 40-pound roll sizes and were sampled only at the start of each roll. Where shipment of prepreg was not required, test lots were divided into two 10-yard rolls and each roll was treated as the sample. Panels were made using a hydraulic press at 325°F and 1000 psi for a curing duration of 2 hours for all prepreg types. The panel sizes and the test conducted from each cured panel are shown below.

CURED PANEL PREPARATIONS

TESTS	SIZE (INCHES)	NUMBER OF PLIES		
		FM 5055	FM 5834	FM 5064J & FM 5839
SpG, Barcol, Compression (W), C.T.E.	6 x 12	10	6 - 8	10
Tensile (W), Flex	8 x 8	10	7 - 8	10
Shear, Acetone Extraction	4 x 4	99	63 - 72	105
Residual Volatiles	4 x 4	19	15 - 18	21

Note: Carbon bars 5 in. x 1/2 in. x 32 plies were staged 22 mins. at 255°F and press molded 10 mins. at 325°F and 1000 psi, for resin content by pyrolysis.

The variability of FM 5834 including resin content and fabric weights caused the changes in the number of plies required to make equivalent panel thicknesses.

The initial run of FM 5839, Lot #2R was outside of the acceptable range for resin content (42%). Panels were made utilizing this test lot, but the results obtained were not included in the statistical analysis and averages. The data for Lot #2R is included in the center of pages #22 through #24 and demonstrates where and to what degree the higher resin content effects the test results. For FM 5064J, identical panels were made for both fabricators even though the flow and volatile content were produced at different levels. The average results from lots made for each fabricator were separately noted on the bottom of pages #18, #19, and #20, but the calculation for A BASIS allowables and the grand totals for FM 5064J include all of the cured panel results. With the exception of residual volatiles, which indicated that HITCO lots had 30% higher residual volatiles than KAISER lots and compressive strengths which indicated KAISER lots were almost 20% higher than the HITCO lots, other cured panel values were within the expected ranges based upon data scatter. Part of the differences in fabricators can be explained by the higher resin content of the HITCO lots which is responsible for the higher residual vols and higher acetone extractables.

II. TEST METHODS AND OBSERVATIONS

A. Tensile Strength, Modulus and Elongation

Tensile samples were cut from a nominal 1/8 inch thick cured panel in the warp direction and were conducted according to method #1011 of Federal Test Method Standard #406. For the carbon/phenolics, FM 5834 had a 39% higher tensile strength than FM 5055B with correspondingly higher modulus and lower elongation. For the carbon/carbon prepgs, the PAN

based FM 5839 had a slightly lower tensile strength than the WCA fabric but higher modulus and lower elongation. The variability of spun PANS is evident in the tensile panels with higher standard deviations than those based on continuous rayon. There were no significant lot to lot variations observed.

B. Compressive Strength and Modulus

Compression samples of the straight side specimen type were cut from the warp direction of the nominal 1/8 inch thick cured panel and conducted according to the procedures of FTMS 406-1021. As shown on page #8, the FM 5055B prepreg produced a normally outstanding compression strength of 56,000 psi, with a standard deviation which was only 5.9% of its ultimate strength, while SWB-8 at a level of 27,600 psi compression had a standard deviation of 8.2%. For the carbon/carbon prepgs, FM 5839 surprisingly showed a higher average compressive strength and a lower standard deviation than its corresponding WCA based prepreg, FM 5064J. FM 5839 maintained a modulus twice as high as FM 5064.

C. Flexural Strength and Modulus

Flexural strength samples were cut from the same panel as the tensile samples and tested using procedure A of FTMS 406-1031. In both classes of prepreg, the ultimate flexural strength for spun PAN fabrics exceeded the continuous rayon based fabrics, while maintaining a higher modulus but with the inherent higher variability mentioned previously for spun PAN. No significant lot to lot variations were noted.

D. Specific Gravity

The specific gravity of a 1/8 inch thick panel measuring 1 in. x 1 in. and weighing $3\frac{1}{2}$ - $4\frac{1}{2}$ gms. was determined by displacement of water. Spun

PAN prepgs showed higher specific gravities than their rayon counterparts and with roughly the same amount of standard deviation. FM 5064 had an unusually low standard deviation of 0.004, but no other significant lot to lot trends were observed.

E. Double Shear Strength

A three-plate jig, machined to accept a 0.375-inch diameter cylinder of prepreg which was cut from a 1 1/8-inch thick stack of 90-105 cured plies, was used to determine the shear strength (double shear). The summary on page #9 shows that for carbon/phenolic prepgs, FM 5055B was 35% higher than FM 5834; while for carbon/carbon prepgs, the spun PAN based FM 5839 was 44% higher than WCA. It is generally recognized that in spun PAN fabrics, the longer the filament length, the lower the shear values, but the higher the tensile strengths. This trade-off must be considered in the proper selection of fiber lengths in spun PAN fabrics.

F. Barcol Hardness

Using a commercially available Barber-Colman Impressor, Model 934-1, ten measurements were taken of the surface of 1/8-inch thick cured panels. It should be noted that the FM 5839 registered 10 points higher than FM 5064J, while the carbon/phenolic prepgs were both in the same general area. No explanation for the difference in the carbon/carbon prepg is readily evident.

G. Residual Volatiles

Three 1-inch² x 1/4-inch thick sections of cured panels were used to determine the volatile loss after 4 hours in the 325°F forced air oven. The data indicate that on the average, the resin content of the cured

panel is a better predictor of residual volatiles than the volatile level in the uncured prepreg. For example, the volatile content of uncured FM 5064J prepreg was 2.8% while FM 5839 uncured prepreg was 2.5%. The residual volatiles were 1.43% and 1.76%, respectively, which follows more closely the increased resin content of the FM 5839. The higher volatile content of CCA-3 fabric apparently is removed during prepping and has no noticeable effect on the residual volatiles of the FM 5055B cured panel.

H. Resin Content By Pyrolysis

A molded bar, 5 in. x $\frac{1}{2}$ in. x $\frac{1}{2}$ in. thick was burned in a Vycor test tube under vacuum and an experimentally determined constant applied to calculate the dry resin content of the cured panel. Both of the spun PAN based prepgs had the expected higher resin content and reasonably good agreement was attained when compared to the Soxhlet resin content of the uncured prepreg, since the prepreg is staged before molding to eliminate resin flow.

COMPARISON OF RESIN CONTENTS (%)

<u>PREPREG TYPE</u>	<u>BY PYROLYSIS EXTRACTION</u>	<u>BY SOXHLET EXTRACTION</u>
FM 5055B	34.6	34.2
FM 5834	36.2	37.3
FM 5064J	31.6	33.7
FM 5839	32.2	34.2

I. Acetone Extraction

Dust from the cutting of the double shear specimen was collected and a screen-cut made between 40 mesh and 140 mesh. The powder was placed in the Soxhlet extraction equipment and refluxed with acetone for 4

hours. The weight loss is reported as a percentage extractable. The acetone extractables of greater than 5% for the carbon/carbon preprints, FM 5839 and FM 5064J demonstrate that a fraction of USP 39A resin is not completely cured at 325°F when the panels are made, but fully cures at a higher temperature range. This higher temperature curing component helps to relieve internal stresses at elevated temperature and is a feature of a superior carbon/carbon resin system.

J. Coefficient of Thermal Expansion (CTE)

Four $\frac{1}{4}$ in. x $\frac{1}{4}$ in. specimens were cut from a 1/8-inch thick cured panel and the Coefficient of Thermal Expansion measured in both a "with ply" (along the $\frac{1}{4}$ -inch dimension) and "cross-ply" (perpendicular to the fabric plies or through the 1/8-inch thickness) direction. The results reported are an average of two specimens in each direction. The with-ply CTE's are measured in line with the plies and are influenced by the fabric fibers. For spun PAN, basically a zero CTE was observed. The cross-ply CTE's were more resin dominated and both types of preprints were in generally good agreement in their class. The standard deviations for these types of measurement are fairly high; approaching \pm 50% of the average value in some cases. Typical CTE curves are attached on pages #25 through #32. The individual charts for each specimen are included in the individual lot fingerprints only.

III. SUMMARY

Some of the variations in spun PAN fabrics are reflected by higher standard deviations of the cured panel strength tests. But the strength variations are at a lesser degree than variations of physical properties. The most significant ultimate strength value is the compressive strength of CCA-3 to the level of 56,000 psi. In nozzle design, one of the major loads places fiber in compression and the higher compressive strength of CCA-3 provides

an additional safety margin. The tensile, compressive, and strength modulus of the spun PAN prepgs imply about 1/2 of the strain with the same strength load. Finally, flexural strength is a handy criterion to monitor the combination of tensile and compressive strengths and both spun PAN prepgs show improved flex values. For residual volatiles, it becomes apparent that the resin content and resin selection are prime drivers for the amount of residual vols; and the acetone extractables on a 325°F cured panel highlight the components of the resin system which makes an outstanding carbon/carbon resin system.

COMPARATIVE CURED PANEL DATA

NAS8-36298

CARBON/PHENOLIC PREPREGS

=====

FM 5055B

	TENSILE STRENGTH	MODULUS	TENSILE ELONG	COMPRESSIVE STRENGTH	COMPRESSIVE MODULUS
GRAND TOTAL	WARP ksi	WARP msi	WARP %	WARP ksi	WARP msi
=====					
AVERAGE	20.16	2.99	1.04	56.20	3.07
STD DEV	1.65	0.14	0.09	3.30	0.18
MINIMUM	16.67	2.68	0.84	42.67	2.71
MAXIMUM	24.08	3.29	1.26	60.79	3.57

FM 5834

	TENSILE STRENGTH	TENSILE MODULUS	TENSILE ELONG	COMPRESSIVE STRENGTH	COMPRESSIVE MODULUS
GRAND TOTAL	WARP ksi	WARP msi	WARP %	WARP ksi	WARP msi
=====					
AVERAGE	28.06	5.29	0.60	27.61	5.25
STD DEV	3.36	0.67	0.06	2.27	0.73
MINIMUM	21.84	4.22	0.50	24.03	4.55
MAXIMUM	33.48	6.41	0.71	32.49	6.80

CARBON/CARBON PREPREGS

=====

FM 5064J

	TENSILE STRENGTH	TENSILE MODULUS	TENSILE ELONG	COMPRESSIVE STRENGTH	COMPRESSIVE MODULUS
GRAND TOTAL	WARP ksi	WARP msi	WARP %	WARP ksi	WARP msi
=====					
AVERAGE	19.74	2.04	1.23	18.75	2.14
STD DEV	0.80	0.13	0.14	2.90	0.12
MINIMUM	18.91	1.81	0.97	14.32	2.02
MAXIMUM	21.89	2.37	1.47	24.51	2.51

FM 5839

	TENSILE STRENGTH	TENSILE MODULUS	TENSILE ELONG	COMPRESSIVE STRENGTH	COMPRESSIVE MODULUS
GRAND TOTAL	WARP ksi	WARP msi	WARP %	WARP ksi	WARP msi
=====					
AVERAGE	18.71	4.05	0.82	22.26	4.49
STD DEV	3.03	0.57	0.15	1.73	0.78
MINIMUM	13.04	2.89	0.56	19.63	3.38
MAXIMUM	23.81	4.88	1.06	24.97	5.98

COMPARATIVE CURED PANEL DATA

NAS8-36298

CARBON/PHENOLIC PREPREGS

=====

FM 5055B

	FLEXURAL STRENGTH	FLEXURAL MODULUS	SPECIFIC GRAVITY	DOUBLE SHEAR STRENGTH	BARCOL HARDNESS
GRAND TOTAL	WARP ksi	WARP msi	CURED units	ksi	CURED units
AVERAGE	33.29	2.72	1.473	4.58	72.6
STD DEV	2.57	0.22	0.012	0.51	1.1
MINIMUM	28.79	1.96	1.421	3.36	70.4
MAXIMUM	41.10	3.19	1.487	6.16	75.0

FM 5834

	FLEXURAL STRENGTH	FLEXURAL MODULUS	SPECIFIC GRAVITY	DOUBLE SHEAR STRENGTH	BARCOL HARDNESS
GRAND TOTAL	WARP ksi	WARP msi	CURED units	ksi	CURED units
AVERAGE	41.97	4.70	1.507	3.40	70.7
STD DEV	4.17	0.43	0.015	0.34	1.3
MINIMUM	35.49	4.06	1.466	2.60	68.80
MAXIMUM	49.84	5.65	1.522	3.99	73.10

CARBON/CARBON PREPREGS

=====

FM 5064J

	FLEXURAL STRENGTH	FLEXURAL MODULUS	SPECIFIC GRAVITY	DOUBLE SHEAR STRENGTH	BARCOL HARDNESS
GRAND TOTAL	WARP ksi	WARP msi	CURED units	ksi	CURED units
AVERAGE	28.05	1.89	1.430	2.53	59.8
STD DEV	1.77	0.21	0.004	0.16	2.8
MINIMUM	25.19	1.59	1.422	2.28	52.40
MAXIMUM	31.86	2.26	1.435	2.87	63.40

FM 5839

	FLEXURAL STRENGTH	FLEXURAL MODULUS	SPECIFIC GRAVITY	DOUBLE SHEAR STRENGTH	BARCOL HARDNESS
GRAND TOTAL	WARP ksi	WARP msi	CURED units	ksi	CURED units
AVERAGE	33.06	3.92	1.564	3.64	69.7
STD DEV	3.93	0.63	0.011	0.38	1.3
MINIMUM	24.78	2.68	1.547	3.03	67.50
MAXIMUM	37.74	5.30	1.590	4.26	72.5

COMPARATIVE CURED PANEL DATA

NAS8-36298

CARBON/PHENOLIC PREPREGS

=====

FM 5055B

=====

GRAND TOTAL	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY	C.T.E. CROSS PLY
	%	%	%	uin/in ⁰ F	uin/in ⁰ F
AVERAGE	1.84	34.57	0.73	4.63	7.67
STD DEV	0.29	1.33	1.90	0.92	1.32
MINIMUM	1.18	32.20	-8.29	2.82	4.45
MAXIMUM	2.56	38.47	2.74	7.58	10.84

FM 5834

=====

GRAND TOTAL	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY	C.T.E. CROSS PLY
	%	%	%	uin/in ⁰ F	uin/in ⁰ F
AVERAGE	2.26	36.19	1.23	-0.07	11.94
STD DEV	0.27	2.07	1.84	1.30	1.84
MINIMUM	1.69	31.78	-0.87	-3.07	8.57
MAXIMUM	2.66	39.40	5.51	1.51	15.69

CARBON/CARBON PREPREGS

=====

FM 5064J

=====

GRAND TOTAL	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY	C.T.E. CROSS PLY
	%	%	%	uin/in ⁰ F	uin/in ⁰ F
AVERAGE	1.43	31.62	5.71	2.60	5.49
STD DEV	0.26	0.94	1.02	1.06	3.10
MINIMUM	0.93	29.38	3.56	-1.07	2.52
MAXIMUM	1.87	32.84	7.36	3.98	14.32

FM 5839

=====

GRAND TOTAL	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY	C.T.E. CROSS PLY
	%	%	%	uin/in ⁰ F	uin/in ⁰ F
AVERAGE	1.76	32.24	5.17	-0.63	6.88
STD DEV	0.23	1.55	1.00	0.72	3.95
MINIMUM	1.19	30.30	3.31	-1.81	3.14
MAXIMUM	1.98	34.21	6.81	0.49	16.44

EM 5055B CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TENSILE STRENGTH WARP ksi	TENSILE MODULUS WARP msi	TENSILE ELONG WARP %	COMPRESSIVE STRENGTH WARP ksi	COMPRESSIVE MODULUS WARP msi
	TEST METHOD	406-1011	406-1011	406-1011	406-1021	406-1021
#1	D09256-S1	21.44	2.68	1.16	57.66	3.22
	-E1	19.57	2.79	1.06	54.24	3.22
	-S2	18.90	2.71	0.97	58.98	3.38
	-E2	21.34	3.07	1.09	58.39	3.57
	-S3	19.97	2.84	1.02	55.44	3.51
	-E3	18.76	2.94	0.95	57.27	3.15
	-S4	18.17	2.89	1.00	54.69	3.18
	-E4	19.08	2.82	1.04	59.59	3.07
	-S5	18.84	2.72	1.03	60.79	3.04
	-E6	20.43	3.00	1.04	57.49	3.04
	-S6	22.62	2.95	1.20	56.02	3.24
	-E6	19.37	2.87	1.07	57.83	3.07
	-S7	21.61	3.03	1.14	56.30	3.15
	-E7	19.76	2.93	1.07	54.70	3.19
	-S8	20.21	2.99	1.01	54.88	3.20
	-E8	20.16	2.99	1.05	58.58	3.25
	-S9	21.75	2.94	1.05	57.03	3.24
	-E9	24.08	3.12	1.17	58.25	2.96
#2	D09274-S1	18.87	3.09	0.91	55.20	3.07
	-E1	19.63	3.15	0.94	58.17	3.01
	-S2	19.71	3.27	0.89	58.54	2.77
	-E2	19.08	3.04	0.96	53.94	2.80
	-S3	17.24	2.92	0.84	59.20	3.24
	-E3	18.44	3.16	0.85	60.14	3.06
	-S4	19.49	3.16	0.88	48.75	2.86
	-E4	19.04	3.29	1.00	53.85	2.73
	-S5	16.77	2.94	0.93	42.67	2.86
	-E5	18.59	3.16	0.99	58.03	2.74
	-S6	18.74	2.93	1.01	50.30	2.85
	-E6	16.67	2.91	0.93	53.94	2.71
	-S7	21.33	2.96	1.11	56.97	3.05
	-E7	20.48	3.02	1.03	58.00	3.02
	-S8	20.96	3.01	1.09	56.21	2.97
	-E8	19.15	3.00	0.93	55.22	3.06
	-E9	19.74	2.94	1.02	55.53	3.06
#3	C02133-S1	20.80	2.95	1.12	60.27	3.13
	-E1	20.83	3.18	0.99	59.78	3.08
	-S2	19.41	2.97	1.03	59.42	3.15
	-E2	22.71	3.21	1.11	58.79	3.08
	-S3	19.93	2.95	1.02	55.45	3.12
	-E3	23.68	3.05	1.26	58.95	2.93
	-S4	22.25	3.07	1.14	59.58	3.10
	-E4	20.85	3.02	1.03	59.68	3.13
	-S5	20.65	2.88	1.10	53.24	3.39
	-E5	19.87	2.90	1.07	56.00	3.11
	-S6	22.53	3.14	1.17	50.63	3.09
	-E6	21.71	2.96	1.10	53.41	3.17
	-S7	21.17	3.18	1.12	56.58	3.12
	-E7	20.57	3.12	1.04	55.88	3.16
#4	D09313- 1	18.00	2.81	0.93	54.99	2.95
	- 2	18.74	2.90	0.94	52.00	2.74
#5	D09335- 1	22.74	2.91	1.18	52.90	2.98
	- 2	22.22	3.00	1.10	58.31	2.90

EM 5055B	TENSILE GRAND TOTAL WARP ksi	TENSILE MODULUS WARP msi	TENSILE ELONG WARP %	COMPRESSIVE STRENGTH WARP ksi	COMPRESSIVE MODULUS WARP msi
AVERAGE	20.16	2.99	1.04	56.20	3.07
STD DEV	1.65	0.14	0.09	3.30	0.18
MINIMUM	16.67	2.68	0.84	42.67	2.71
MAXIMUM	24.08	3.29	1.26	60.79	3.57

FM 5055B CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
#1	TEST METHOD DO9256-S1	406-1031 31.43	406-1031 2.34	D-792 1.471	406-1041A 4.18	D-2583 72.9
	-E1	32.61	2.32	1.476	4.03	71.9
	-S2	32.65	2.20	1.475	3.74	73.8
	-E2	33.62	1.96	1.477	4.64	73.9
	-S3	28.99	2.28	1.478	4.36	74.6
	-E3	28.79	2.47	1.469	4.12	72.9
	-S4	32.06	2.74	1.475	4.45	73.6
	-E4	34.13	2.84	1.451	4.46	73.3
	-S5	33.77	2.72	1.466	3.91	73.0
	-E6	32.70	2.68	1.464	4.50	74.8
	-S6	36.84	2.91	1.479	4.71	71.0
	-E6	34.09	3.17	1.475	4.74	74.0
	-S7	33.17	2.92	1.478	4.88	72.5
	-E7	34.94	2.95	1.476	4.79	73.6
	-S8	33.64	2.66	1.472	4.44	71.5
	-E8	34.14	2.67	1.480	4.11	71.3
	-S9	34.95	2.68	1.484	4.26	73.1
	-E9	37.35	2.75	1.448	4.00	71.9
#2	DO9274-S1	29.78	2.76	1.485	3.86	71.8
	-E1	34.01	2.58	1.456	4.47	72.3
	-S2	33.90	2.82	1.462	4.25	71.8
	-E2	31.96	2.98	1.472	4.16	73.4
	-S3	29.46	2.86	1.487	4.48	71.9
	-E3	31.18	2.69	1.481	4.09	71.2
	-S4	32.93	2.82	1.483	3.36	72.0
	-E4	29.98	2.83	1.472	4.56	72.3
	-S5	29.47	2.72	1.480	4.33	72.1
	-E5	32.59	2.74	1.470	4.53	72.2
	-S6	29.06	2.63	1.482	4.69	70.7
	-E6	30.48	2.68	1.476	3.87	71.6
	-S7	35.35	2.97	1.481	5.50	73.2
	-E7	32.40	2.98	1.475	5.13	72.5
	-S8	34.29	2.95	1.479	4.87	73.0
	-E8	34.92	3.00	1.477	5.48	73.6
	-E9	32.16	2.97	1.480	4.98	72.4
#3	CO2133-S1	36.69	2.72	1.477	5.38	72.0
	-E1	37.73	2.87	1.445	6.16	75.0
	-S2	32.60	2.66	1.483	4.49	72.9
	-E2	38.30	2.77	1.421	4.64	70.4
	-S3	35.47	2.74	1.483	5.33	71.0
	-E3	41.10	2.82	1.481	4.40	73.0
	-S4	33.90	2.58	1.479	4.90	72.0
	-E4	33.91	2.63	1.469	4.39	73.0
	-S5	36.51	3.19	1.484	5.23	71.2
	-E5	31.35	2.61	1.478	5.03	74.6
	-S6	34.18	2.58	1.481	4.93	73.7
	-E6	34.78	2.70	1.486	5.24	73.3
	-S7	30.87	2.67	1.482	4.86	74.0
	-E7	33.95	2.61	1.480	5.04	73.0
#4	DO9313-1	31.13	2.80	1.476	4.66	72.5
	-2	29.69	2.85	1.453	4.17	71.3
#5	DO9335-1	34.09	2.75	1.478	4.44	71.5
	-2	34.47	2.57	1.466	4.73	72.9

FM 5055B GRAND TOTAL	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
AVERAGE	33.29	2.72	1.473	4.58	72.6
STD DEV	2.57	0.22	0.012	0.51	1.1
MINIMUM	28.79	1.96	1.421	3.36	70.4
MAXIMUM	41.10	3.19	1.487	6.16	75.0

FM 5055B CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY	C.T.E. CROSS PLY
					uin/in°F	uin/in°F
#1	TEST METHOD DO9256-S1	PTM-98	CTM-14B	CTM-18A	PTM-61B	PTM-61B
	-E1	1.67	34.95	2.23	3.13	6.89
	-S2	1.53	33.86	2.13	4.17	7.60
	-E2	1.76	33.64	2.41	3.73	5.38
	-S3	2.20	34.58	2.66	3.46	8.15
	-E3	1.67	33.70	2.30	3.41	5.79
	-S4	1.87	34.41	1.97	3.86	8.69
	-E4	1.78	36.20	2.14	3.76	5.74
	-S5	1.91	35.22	1.92	3.32	7.32
	-E6	1.85	34.94	2.33	3.73	8.16
	-S6	2.00	33.52	2.05	5.07	7.03
	-E7	2.00	33.61	1.83	2.82	7.62
	-S7	1.92	33.65	1.86	4.31	8.53
	-E8	2.13	35.04	2.11	4.41	5.87
	-S8	2.18	32.65	1.56	4.64	6.97
	-E9	1.79	33.82	1.81	4.74	9.58
	-S9	1.72	33.35	1.99	4.77	8.70
	-E10	1.54	34.40	1.78	4.52	6.89
	-S11	1.74	36.30	1.21	3.77	7.46
#2	DO9274-S1	2.21	36.17	0.28	5.37	6.50
	-E1	2.31	35.86	0.25	5.44	10.43
	-S2	2.01	35.25	0.13	4.88	8.78
	-E2	2.32	34.61	0.46	5.92	9.31
	-S3	1.79	35.34	-0.24	4.91	10.18
	-E4	2.45	35.31	-0.05	2.99	7.59
	-S5	2.56	32.47	0.10	5.12	8.68
	-E6	2.41	34.52	-0.41	4.11	6.65
	-S7	1.49	35.64	-0.09	3.97	7.24
	-E8	1.52	34.00	-0.35	4.72	8.47
	-S9	1.54	34.10	0.17	7.58	6.42
	-E10	2.18	34.33	0.09	5.48	8.59
	-S11	1.66	33.90	0.18	4.55	8.12
	-E12	1.70	37.24	0.32	4.28	8.84
	-S13	1.18	35.50	0.47	5.06	6.38
	-E14	1.77	38.47	-0.03	4.75	7.56
	-S15	1.81	36.73	-0.38	6.71	8.62
#3	CO2133-S1	1.66	34.38	1.74	5.00	6.25
	-E1	1.97	32.63	0.88	5.38	9.05
	-S2	2.16	34.54	-0.20	5.51	7.34
	-E3	1.59	32.21	1.43	5.52	7.45
	-S4	1.78	34.57	0.53	4.25	6.29
	-E5	1.90	33.97	1.24	4.77	8.15
	-S6	1.99	32.55	1.38	5.23	7.82
	-E7	1.52	32.38	0.91	4.32	6.66
	-S8	2.00	35.20	1.89	4.87	7.44
	-E9	1.85	34.00	1.75	5.28	7.80
	-S10	1.64	35.06	-1.37	6.13	10.84
	-E11	1.74	34.46	-1.69	4.97	8.80
	-S12	1.97	36.36	-5.81	5.63	9.05
	-E13	1.91	34.26	-8.29	4.48	8.75
#4	DO9313-1	1.33	33.94	0.57	3.92	6.07
	-2	1.56	35.30	1.25	4.12	6.93
#5	DO9335-1	1.39	32.20	2.60	3.63	4.45
	-2	1.60	36.74	2.74	5.00	6.53
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<u>FM 5055B</u>		GRAND TOTAL	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY
			%	%	%	uin/in°F
		AVERAGE	1.84	34.57	0.73	4.63
		STD DEV	0.29	1.33	1.90	0.92
		MINIMUM	1.18	32.20	-8.29	2.82
		MAXIMUM	2.56	38.47	2.74	7.58
						uin/in°F

FM 5055B CURED PANEL
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	TENSILE STRENGTH	TENSILE MODULUS	TENSILE ELONG	COMPRESSIVE STRENGTH	COMPRESSIVE MODULUS
	WARP ksi	WARP msi	WARP %	WARP ksi	WARP msi
LOT #1	20.34	2.90	1.06	57.12	3.20
LOT #2	19.05	3.06	0.96	54.98	2.93
LOT #3	21.21	3.04	1.09	56.98	3.13
LOT #4	18.37	2.86	0.93	53.49	2.85
LOT #5	22.48	2.95	1.14	55.60	2.94
FM	=====	=====	=====	=====	=====
5055B GRAND AVG.	20.16	2.99	1.04	56.20	3.07
STD DEV	1.65	0.14	0.09	3.30	0.18
COUNT	53	53	53	53	53
A BASIS FACTOR	2.844	2.844	2.844	2.844	2.844
A BASIS MINIMUM	15.48	2.60	0.77	46.81	2.55
A BASIS MAXIMUM	24.85	3.38	1.30	65.59	3.60

LOT AVERAGES	FLEXURAL STRENGTH	FLEXURAL MODULUS	SPECIFIC GRAVITY	DOUBLE SHEAR STRENGTH	BARCOL HARDNESS
	WARP ksi	WARP msi	CURED units	ksi	units
LOT #1	33.33	2.62	1.472	4.35	73.0
LOT #2	32.00	2.82	1.476	4.51	72.2
LOT #3	35.10	2.72	1.473	5.00	72.8
LOT #4	30.41	2.83	1.464	4.42	71.9
LOT #5	34.28	2.66	1.472	4.58	72.2
FM	=====	=====	=====	=====	=====
5055B GRAND AVG.	33.29	2.72	1.473	4.58	72.6
STD DEV	2.57	0.22	0.012	0.51	1.1
COUNT	53	53	53	53	53
A BASIS FACTOR	2.844	2.844	2.844	2.844	2.844
A BASIS MINIMUM	25.97	2.08	1.439	3.12	69.5
A BASIS MAXIMUM	40.61	3.36	1.508	6.04	75.7

LOT AVERAGES	RESIDUAL VOLATILES	RESIN CONTENT	ACETONE EXTRACTION	C.T.E. WITH PLY	C.T.E. CROSS PLY
	CURED %	PYROLYSIS %	CURED %	uin/in °F	uin/in °F
LOT #1	1.85	34.32	2.02	3.98	7.35
LOT #2	1.93	35.26	0.05	5.05	8.14
LOT #3	1.83	34.04	-0.40	5.09	7.98
LOT #4	1.45	34.62	0.91	4.02	6.50
LOT #5	1.50	34.47	2.67	4.31	5.49
FM	=====	=====	=====	=====	=====
5055B GRAND AVG.	1.84	34.57	0.73	4.63	7.67
STD DEV	0.29	1.33	1.90	0.92	1.32
COUNT	53	53	53	53	53
A BASIS FACTOR	2.844	2.844	2.844	2.844	2.844
A BASIS MINIMUM	1.01	30.79	-4.68	2.02	3.92
A BASIS MAXIMUM	2.68	38.35	6.15	7.24	11.41

FM 5834 CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TENSILE STRENGTH kpsi	TENSILE MODULUS mpsi	TENSILE ELONG %	COMPRESSIVE STRENGTH kpsi	COMPRESSIVE MODULUS mpsi
	TEST METHOD	406-1011	406-1011	406-1011	406-1021	406-1021
#1	D09255- 1	33.48	6.32	0.59	27.01	6.11
	- 2	29.02	5.89	0.52	25.19	6.43
#2	D09275-S1	24.15	4.99	0.55	24.90	4.97
	-S2	23.64	4.99	0.59	24.03	4.55
	-S3	28.27	5.00	0.63	27.05	4.82
	-S4	25.60	5.45	0.55	26.12	5.14
	-S5	21.84	4.22	0.62	25.91	4.78
	-S6	29.98	5.86	0.56	28.36	4.80
	-S7	26.70	5.49	0.60	28.27	4.77
#3	D09233- 1	30.53	5.92	0.62	29.92	6.11
	- 2	31.01	6.41	0.50	28.80	6.80
#4	D09314- 1	33.19	5.00	0.69	32.49	5.09
	- 2	26.95	4.69	0.65	27.55	4.72
#5	D09336- 1	28.63	4.51	0.71	30.56	4.81
	- 2	27.88	4.63	0.69	28.03	4.82

FM 5834	TENSILE STRENGTH WARP kpsi	TENSILE MODULUS WARP mpsi	TENSILE ELONG WARP %	COMPRESSIVE STRENGTH WARP kpsi	COMPRESSIVE MODULUS WARP mpsi
GRAND TOTAL					
AVERAGE	28.06	5.29	0.60	27.61	5.25
STD DEV	3.36	0.67	0.06	2.27	0.73
MINIMUM	21.84	4.22	0.50	24.03	4.55
MAXIMUM	33.48	6.41	0.71	32.49	6.80

FM 5834 CURED PANEL
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	TENSILE STRENGTH WARP kpsi	TENSILE MODULUS WARP mpsi	TENSILE ELONG WARP %	COMPRESSIVE STRENGTH WARP kpsi	COMPRESSIVE MODULUS WARP mpsi
LOT #1	31.25	6.11	0.55	26.10	6.27
LOT #2	25.74	5.14	0.59	26.38	4.83
LOT #3	30.77	6.17	0.56	29.36	6.45
LOT #4	30.07	4.84	0.67	30.02	4.91
LOT #5	28.26	4.57	0.70	29.30	4.81
FM 5834 GRAND AVG	28.06	5.29	0.60	27.61	5.25
STD DEV	3.36	0.67	0.06	2.27	0.73
COUNT	15	15	15	15	15
<u>A BASIS FACTOR</u>	3.520	3.520	3.520	3.520	3.520
<u>A BASIS MINIMUM</u>	16.23	2.92	0.38	19.61	2.69
<u>A BASIS MAXIMUM</u>	39.89	7.67	0.82	35.61	7.80

FM 5834 CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. end SAMPLE	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
	TEST METHOD	406-1031	406-1031	D-792	406-1041A	D-2583
#1	D09255- 1	45.95	4.87	1.522	2.60	69.0
	- 2	41.99	4.52	1.519	3.12	70.9
#2	D09275-S1	38.26	4.26	1.513	3.40	69.5
	-S2	35.49	4.39	1.522	3.25	68.8
	-S3	45.46	5.65	1.500	3.51	70.5
	-S4	37.77	4.44	1.520	3.64	70.4
	-S5	35.88	4.06	1.507	3.39	69.7
	-S6	43.66	5.06	1.491	3.32	70.8
	-S7	41.29	4.66	1.512	3.54	72.4
#3	D09233- 1	43.67	4.81	1.511	3.80	73.1
	- 2	46.59	5.50	1.518	3.99	73.0
#4	D09314- 1	49.84	4.65	1.498	3.36	70.2
	- 2	42.36	4.66	1.466	3.08	71.1
#5	D09336- 1	43.07	4.59	1.497	3.72	70.6
	- 2	38.28	4.35	1.504	3.24	70.9
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<u>FM 5834</u>	GRAND TOTAL	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
	AVERAGE	41.97	4.70	1.507	3.40	70.7
	STD DEV	4.17	0.43	0.015	0.34	1.3
	MINIMUM	35.49	4.06	1.466	2.60	68.8
	MAXIMUM	49.84	5.65	1.522	3.99	73.1

FM 5834 CURED PANEL
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
LOT #1	43.97	4.70	1.520	2.86	70.0
LOT #2	39.69	4.65	1.509	3.44	70.3
LOT #3	45.13	5.15	1.514	3.90	73.1
LOT #4	46.10	4.66	1.482	3.22	70.7
LOT #5	40.68	4.47	1.501	3.48	70.8
FM 5834 GRAND AVG	41.97	4.70	1.507	3.40	70.7
STD DEV	4.17	0.43	0.015	0.34	1.3
COUNT	15	15	15	15	15
<u>A BASIS FACTOR</u>	3.520	3.520	3.520	3.520	3.520
<u>A BASIS MINIMUM</u>	27.31	3.17	1.454	2.21	66.2
<u>A BASIS MAXIMUM</u>	56.63	6.23	1.559	4.58	75.3

FM 5834 CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY	C.T.E. CROSS PLY
	TEST METHOD	PTM-98	CTM-14B	CTM-18A	PTM-61B	PTM-61B
#1	D09255- 1	2.29	34.19	-0.76	-2.06	11.48
	- 2	2.14	34.04	-0.87	-2.08	12.78
#2	D09275-S1	2.34	38.81	0.58	0.40	11.62
	-S2	2.33	36.10	0.30	0.62	11.19
	-S3	2.62	35.56	0.38	-0.39	11.20
	-S4	2.33	37.05	0.98	0.60	13.38
	-S5	2.66	36.73	0.66	0.98	12.94
	-S6	2.42	39.40	1.01	0.44	15.69
	-S7	2.44	35.01	-0.13	-3.07	14.24
#3	D09233- 1	1.72	35.14	1.11	0.52	10.42
	- 2	1.69	31.78	1.01	0.33	9.09
#4	D09314- 1	2.25	38.06	5.23	1.51	11.99
	- 2	2.38	35.15	5.51	0.84	12.96
#5	D09336- 1	2.20	37.59	2.01	0.52	11.55
	- 2	2.11	38.21	1.42	-0.20	8.57
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<u>FM 5834</u>	<u>GRAND TOTAL</u>	<u>RESIDUAL VOLATILES CURED</u>	<u>RESIN CONTENT PYROLYSIS</u>	<u>ACETONE EXTRACTION CURED</u>	<u>C.T.E. WITH PLY</u>	<u>C.T.E. CROSS PLY</u>
		%	%	%	uin/in F	uin/in F
	AVERAGE	2.26	36.19	1.23	-0.07	11.94
	STD DEV	0.27	2.07	1.84	1.30	1.84
	MINIMUM	1.69	31.78	-0.87	-3.07	8.57
	MAXIMUM	2.66	39.40	5.51	1.51	15.69

FM 5834 CURED PANEL
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	RESIDUAL VOLATILES CURED	RESIN CONTENT PYROLYSIS	ACETONE EXTRACTION CURED	C.T.E. WITH PLY	C.T.E. CROSS PLY
LOT #1	2.22	34.11	-0.81	-2.06	12.13
LOT #2	2.45	36.95	0.54	-0.06	12.89
LOT #3	1.70	33.46	1.06	0.42	9.76
LOT #4	2.32	36.60	5.37	1.18	12.47
LOT #5	2.16	37.90	1.71	0.16	10.06
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<u>FM 5834</u>	<u>GRAND AVG</u>	<u>2.26</u>	<u>36.19</u>	<u>1.23</u>	<u>-0.07</u>
	STD DEV	0.27	2.07	1.84	1.30
	COUNT	15	15	15	15
<u>A BASIS FACTOR</u>	3.520	3.520	3.520	3.520	3.520
<u>A BASIS MINIMUM</u>	1.30	28.92	-5.26	-4.65	5.45
<u>A BASIS MAXIMUM</u>	3.22	43.46	7.72	4.51	18.42

FM 5064J CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TENSILE STRENGTH kpsi	TENSILE MODULUS mksi	TENSILE ELONG %	COMPRESSIVE STRENGTH kpsi	COMPRESSIVE MODULUS mksi
<u>HITCO 150 psi</u>						
	TEST METHOD	406-1011	406-1011	406-1011	406-1021	406-1021
#1(H)	C02134-S1	19.42	2.00	1.36	18.28	2.30
	-E1	19.13	1.94	1.31	15.68	2.23
	-S2	19.06	1.92	1.35	16.39	2.09
	-E2	20.79	2.08	1.46	19.74	2.14
#2(H)	D09279-S1	19.16	1.81	1.21	15.81	2.07
#3(H)	C02137-S1	19.93	1.95	1.27	18.33	2.26
#4(H)	D09315-S1	20.40	2.09	1.29	15.03	2.06
	-E1	20.62	1.97	1.30	19.83	2.04
#5(H)	D09337- 1	19.66	1.90	1.28	17.49	2.13
	- 2	21.89	1.99	1.37	14.42	2.18
<u>KAISER 1000 psi</u>						
#1(K)	C02135-S1	20.61	1.96	1.47	14.32	2.51
#2(K)	D09280-S1	20.07	2.19	1.01	20.36	2.07
	-E1	19.00	2.08	1.09	22.65	2.04
	-S2	19.21	2.15	1.10	22.04	2.07
	-E2	19.04	2.10	1.09	22.68	2.26
	-S3	19.27	2.17	1.15	24.51	2.05
	-E3	18.91	2.37	0.97	19.69	2.17
#3(K)	C02138-S1	18.92	1.91	1.16	18.91	2.15
#4(K)	D09316-S1	19.56	2.13	1.18	19.81	2.02
	-E1	20.04	2.15	1.27	19.12	2.06
<hr/>						
<u>FM 5064J</u>						
	GRAND TOTAL	TENSILE STRENGTH kpsi	TENSILE MODULUS mksi	TENSILE ELONG %	COMPRESSIVE STRENGTH kpsi	COMPRESSIVE MODULUS mksi
	AVERAGE	19.74	2.04	1.23	18.75	2.14
	STD DEV	0.80	0.13	0.14	2.90	0.12
	MINIMUM	18.91	1.81	0.97	14.32	2.02
	MAXIMUM	21.89	2.37	1.47	24.51	2.51
<hr/>						
<u>HITCO AVERAGE</u>		20.01	1.97	1.32	17.10	2.15
	STD DEV	0.91	0.08	0.07	1.92	0.09
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<u>KAISER AVERAGE</u>		19.46	2.12	1.15	20.41	2.14
	STD DEV	0.59	0.13	0.14	2.82	0.15

FM 5064J CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
HITCO 150 psi						
	TEST METHOD	406-1031	406-1031	D-792	406-1041A	D-2583
#1(H) CO2134-S1		27.69	1.65	1.422	2.46	61.8
	-E1	26.72	1.68	1.424	2.57	61.5
	-S2	25.49	1.64	1.426	2.43	62.4
	-E2	26.33	1.75	1.425	2.45	63.4
#2(H) D09279-S1		27.43	1.87	1.431	2.60	52.4
#3(H) CO2137-S1		28.48	1.60	1.430	2.45	61.9
#4(H) D09315-S1		27.24	2.00	1.428	2.49	57.2
	-E1	29.94	2.26	1.424	2.70	62.0
#5(H) D09337- 1		28.38	1.99	1.435	2.28	58.9
	- 2	25.19	1.81	1.434	2.34	59.5
KAI SER 1000 psi						
#1(K) CO2135-S1		28.60	1.74	1.429	2.64	61.5
#2(K) D09280-S1		29.09	2.19	1.430	2.51	59.2
	-E1	29.26	2.02	1.434	2.87	59.9
	-S2	28.55	1.98	1.432	2.75	57.1
	-E2	31.86	2.17	1.435	2.66	55.2
	-S3	31.75	2.15	1.432	2.36	63.0
	-E3	26.50	1.91	1.431	2.57	60.6
#3(K) CO2138-S1		27.15	1.59	1.435	2.73	61.9
#4(K) D09316-S1		27.34	1.91	1.425	2.40	59.2
	-E1	27.91	1.92	1.434	2.34	58.0
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FM 5064J		FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
GRAND TOTAL						
AVERAGE		28.05	1.89	1.430	2.53	59.8
STD DEV		1.77	0.21	0.004	0.16	2.8
MINIMUM		25.19	1.59	1.422	2.28	52.4
MAXIMUM		31.86	2.26	1.435	2.87	63.4
HITCO AVERAGE		27.29	1.82	1.428	2.48	60.1
STD DEV		1.44	0.21	0.004	0.12	3.3
KAI SER AVERAGE		28.80	1.96	1.432	2.58	59.6
STD DEV		1.81	0.19	0.003	0.18	2.4

FM 5064J CURED PANEL DATA
AVERAGE TEST RESULTS

NAS8-36298

NASA LOT NO. NO.	LOT NO. and SAMPLE	RESIDUAL VOLATILES	RESIN CONTENT	ACETONE EXTRACTION	C.T.E. WITH PLY	C.T.E. CROSS PLY
<u>HITCO 150 psi</u>	<u>TEST METHOD</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>uin/in °F</u>	<u>uin/in °F</u>
	PTM-98	CTM-14B	CTM-18A	PTM-61B	PTM-61B	
#1(H) CO2134-S1		1.72	31.39	6.52	-1.07	3.76
	-E1	1.65	32.38	7.36	3.24	8.45
	-S2	1.84	32.20	7.26	3.21	6.76
	-E2	1.70	32.02	6.99	2.83	6.39
#2(H) D09279-S1		1.28	32.35	6.13	2.63	6.07
#3(H) CO2137-S1		1.48	31.99	3.95	3.98	14.32
#4(H) D09315-S1		1.48	32.58	4.75	2.67	2.52
	-E1	1.44	32.18	5.72	2.99	3.06
#5(H) D09337- 1		1.87	32.84	6.03	1.79	2.92
	- 2	1.71	31.13	6.67	1.62	3.11
<u>KAISER 1000 psi</u>						
#1(K) CO2135-S1		1.04	31.15	5.29	2.44	8.76
#2(K) D09280-S1		1.36	30.32	5.03	2.80	5.33
	-E1	1.36	32.71	6.26	3.49	5.17
	-S2	1.40	32.42	5.26	3.97	5.45
	-E2	1.40	31.96	5.17	2.72	3.00
	-S3	1.33	31.72	5.62	2.37	2.59
	-E3	1.29	30.50	4.88	2.69	3.59
#3(K) CO2138-S1		0.93	30.47	3.56	3.05	10.83
#4(K) D09316-S1		1.21	29.38	5.60	2.23	3.32
	-E1	1.16	30.79	6.16	2.34	4.50
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
<u>FM 5064J</u>	<u>GRAND TOTAL</u>	<u>RESIDUAL VOLATILES</u>	<u>RESIN CONTENT</u>	<u>ACETONE EXTRACTION</u>	<u>C.T.E. WITH PLY</u>	<u>C.T.E. CROSS PLY</u>
		<u>%</u>	<u>%</u>	<u>%</u>	<u>uin/in °F</u>	<u>uin/in °F</u>
AVERAGE		1.43	31.62	5.71	2.60	5.49
STD DEV		0.26	0.94	1.02	1.06	3.10
MINIMUM		0.93	29.38	3.56	-1.07	2.52
MAXIMUM		1.87	32.84	7.36	3.98	14.32
<u>HITCO AVERAGE</u>		1.62	32.11	6.14	2.39	5.73
STD DEV		0.19	0.52	1.09	1.39	3.63
<u>KAISER AVERAGE</u>		1.25	31.14	5.28	2.81	5.25
STD DEV		0.16	1.05	0.76	0.56	2.64

FM 5064J CURED PANEL
 LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES for LARGE LOTS	TENSILE STRENGTH WARP ksi	TENSILE MODULUS WARP msi	TENSILE ELONG %	COMPRESSIVE STRENGTH WARP ksi	COMPRESSIVE MODULUS WARP msi
HITCO #1 C02134	19.60	1.98	1.37	17.52	2.19
HITCO #4 D09315	20.51	2.03	1.29	17.43	2.05
HITCO #5 D09337	20.77	1.95	1.33	15.95	2.16
KAISER#2 D09280	19.25	2.18	1.07	21.99	2.11
KAISER#4 D09316	19.80	2.14	1.23	19.46	2.04
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5064J GRAND AVG	19.74	2.04	1.23	18.75	2.14
STD DEV	0.80	0.13	0.14	2.90	0.12
COUNT	20	20	20	20	20
<u>A BASIS FACTOR</u>	3.295	3.295	3.295	3.295	3.295
<u>A BASIS MINIMUM</u>	17.10	1.61	0.77	9.21	1.75
<u>A BASIS MAXIMUM</u>	22.37	2.47	1.70	28.29	2.54

LOT AVERAGES for LARGE LOTS	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP msi	SPECIFIC GRAVITY CURED	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED
HITCO #1 C02134	26.56	1.68	1.424	2.48	62.3
HITCO #4 D09315	28.59	2.13	1.426	2.59	59.6
HITCO #5 D09337	26.79	1.90	1.434	2.31	59.2
KAISER#2 D09280	29.50	2.07	1.432	2.62	59.2
KAISER#4 D09316	27.63	1.92	1.429	2.37	58.6
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5064J GRAND AVG	28.05	1.89	1.430	2.53	59.8
STD DEV	1.77	0.21	0.004	0.16	2.8
COUNT	20	20	20	20	20
<u>A BASIS FACTOR</u>	3.295	3.295	3.295	3.295	3.295
<u>A BASIS MINIMUM</u>	22.22	1.21	1.416	2.00	50.6
<u>A BASIS MAXIMUM</u>	33.87	2.57	1.444	3.06	69.1

LOT AVERAGES for LARGE LOTS	RESIDUAL VOLATILES CURED %	RESIN CONTENT PYROLYSIS %	ACETONE EXTRACTION CURED %	C.T.E. WITH PLY uin/in°F	C.T.E. CROSS PLY uin/in°F
HITCO #1 C02134	1.73	32.00	7.03	2.05	6.34
HITCO #4 D09315	1.46	32.38	5.24	2.83	2.79
HITCO #5 D09337	1.79	31.98	6.35	1.70	3.01
KAISER#2 D09280	1.35	31.61	5.37	3.01	4.19
KAISER#4 D09316	1.18	30.09	5.88	2.28	3.91
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5064J GRAND AVG	1.43	31.62	5.71	2.60	5.49
STD DEV	0.26	0.94	1.02	1.06	3.10
COUNT	20	20	20	20	20
<u>A BASIS FACTOR</u>	3.295	3.295	3.295	3.295	3.295
<u>A BASIS MINIMUM</u>	0.59	28.51	2.36	-0.88	-4.73
<u>A BASIS MAXIMUM</u>	2.28	34.74	9.06	6.08	15.71

FM 5839 CURED PANEL DATA
AVERAGE TEST RESULTS

Page #22

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	TENSILE STRENGTH kpsi	TENSILE MODULUS msi	TENSILE ELONG %	COMPRESSIVE STRENGTH kpsi	COMPRESSIVE MODULUS msi
	TEST METHOD	406-1011	406-1011	406-1011	406-1021	406-1021
#1	C02136- 1	23.81	4.88	1.01	22.05	5.98
	- 2	21.19	4.62	0.89	19.63	5.75
#2	D09318- 1	16.88	4.11	0.61	22.75	3.55
	- 2	15.21	3.25	1.06	23.39	3.44
#3	C02139- 1	13.04	2.89	0.85	20.05	3.38
	- 2	16.76	3.47	0.95	20.50	3.92
#4	D09317-S1	21.14	4.14	0.97	23.91	4.69
	-S2	20.53	4.30	0.79	22.10	4.38
	-S3	18.62	4.60	0.63	22.78	4.38
	-S4	17.29	4.60	0.56	19.67	5.04
	-S5	18.86	4.19	0.74	24.23	4.39
	-S6	15.77	3.53	0.78	22.19	4.42
#5	D09338- 1	21.00	4.03	0.85	24.97	4.96
	- 2	21.90	4.02	0.77	23.45	4.54
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<u>FM 5839</u>		TENSILE STRENGTH	TENSILE MODULUS	TENSILE ELONG	COMPRESSIVE STRENGTH	COMPRESSIVE MODULUS
GRAND TOTAL		WARP kpsi	WARP msi	WARP %	WARP kpsi	WARP msi
AVERAGE		18.71	4.05	0.82	22.26	4.49
STD DEV		3.03	0.57	0.15	1.73	0.78
MINIMUM		13.04	2.89	0.56	19.63	3.38
MAXIMUM		23.81	4.88	1.06	24.97	5.98
LOT						
#2	D09281- 1	10.95	1.99	1.32	24.34	3.91
REJECT	- 2	16.59	2.99	0.86	24.49	3.79
	AVERAGE	13.77	2.49	1.09	24.41	3.85

FM 5839 CURED PANEL
LOT AVERAGES AND STATISTICAL SUMMARY

NAS8-36298

LOT AVERAGES	TENSILE STRENGTH	TENSILE MODULUS	TENSILE ELONG	COMPRESSIVE STRENGTH	COMPRESSIVE MODULUS
	WARP kpsi	WARP msi	WARP %	WARP kpsi	WARP msi
LOT #1	22.50	4.75	0.95	20.84	5.87
LOT #2	16.05	3.68	0.83	23.07	3.50
LOT #3	14.90	3.18	0.90	20.28	3.65
LOT #4	18.70	4.23	0.74	22.48	4.55
LOT #5	21.45	4.03	0.81	24.21	4.75
FM 5839 GRAND AVG.	18.71	4.05	0.82	22.26	4.49
STD DEV	3.03	0.57	0.15	1.73	0.78
COUNT	14	14	14	14	14
<u>A BASIS FACTOR</u>	3.585	3.585	3.585	3.585	3.585
<u>A BASIS MINIMUM</u>	7.86	1.99	0.27	16.06	1.68
<u>A BASIS MAXIMUM</u>	29.56	6.11	1.36	28.46	7.29

(NOTE: TOTALS DO NOT INCLUDE LOT #2 REJECT)

FM 5839 CURED PANEL DATA
AVERAGE TEST RESULTS

Page #23

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP mbi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
	TEST METHOD	406-1031	406-1031	D-792	406-1041A	D-2583
#1	C02136- 1	37.62	3.97	1.564	3.62	68.2
	- 2	35.15	4.06	1.566	4.09	68.0
#2	D09318- 1	30.60	3.62	1.568	3.15	67.5
	- 2	28.09	3.09	1.557	3.71	69.5
#3	C02139- 1	24.78	2.68	1.579	3.96	70.5
	- 2	29.02	3.21	1.555	3.55	72.5
#4	D09317-S1	35.07	4.12	1.564	3.52	70.5
	-S2	34.10	4.08	1.562	3.63	70.7
	-S3	32.51	4.20	1.572	3.05	70.5
	-S4	31.87	4.15	1.590	3.03	69.3
	-S5	37.74	5.30	1.565	3.45	70.7
	-S6	32.35	3.86	1.553	3.93	70.2
#5	D09338- 1	36.56	4.25	1.555	3.99	69.0
	- 2	37.35	4.21	1.547	4.26	68.9
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FM 5839	GRAND TOTAL	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP mbi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
	AVERAGE	33.06	3.92	1.564	3.64	69.7
	STD DEV	3.93	0.63	0.011	0.38	1.3
	MINIMUM	24.78	2.68	1.547	3.03	67.5
	MAXIMUM	37.74	5.30	1.590	4.26	72.5
LOT						
#2	D09281- 1	21.19	1.88	1.522	4.75	68.8
REJECT	- 2	28.70	2.68	1.511	4.62	69.5
	AVERAGE	24.95	2.28	1.517	4.69	69.2

**FM 5839 CURED PANEL
LOT AVERAGES AND STATISTICAL SUMMARY**

NAS8-36298

LOT AVERAGES	FLEXURAL STRENGTH WARP ksi	FLEXURAL MODULUS WARP mbi	SPECIFIC GRAVITY CURED units	DOUBLE SHEAR STRENGTH ksi	BARCOL HARDNESS CURED units
LOT #1	36.38	4.02	1.565	3.85	68.1
LOT #2	29.35	3.36	1.562	3.43	68.5
LOT #3	26.90	2.95	1.567	3.76	71.5
LOT #4	33.94	4.29	1.568	3.44	70.3
LOT #5	36.96	4.23	1.551	4.12	69.0
FM 5839 GRAND AVG.	33.06	3.92	1.564	3.64	69.7
STD DEV	3.93	0.63	0.011	0.38	1.3
COUNT	14	14	14	14	14
<u>A BASIS FACTOR</u>	3.585	3.585	3.585	3.585	3.585
<u>A BASIS MINIMUM</u>	18.97	1.66	1.524	2.26	64.91
<u>A BASIS MAXIMUM</u>	47.14	6.17	1.604	5.01	74.52

(NOTE: TOTALS DO NOT INCLUDE LOT #2 REJECT)

FM 5839 CURED PANEL DATA
AVERAGE TEST RESULTS

Page #24

NAS8-36298

NASA LOT NO.	LOT NO. and SAMPLE	RESIDUAL VOLATILES %	RESIN CONTENT %	ACETONE EXTRACTION %	C.T.E. WITH PLY uin/in °F	C.T.E. CROSS PLY uin/in °F
TEST METHOD		PTM-98	CTM-14B	CTM-18A	PTM-61B	PTM-61B
#1	CO2136- 1	1.77	31.64	4.71	-0.42	12.98
	- 2	1.53	30.30	4.07	-1.81	16.44
#2	D09318- 1	1.19	30.55	5.45	-1.13	4.61
	- 2	1.38	33.63	4.73	0.49	3.14
#3	CO2139- 1	1.76	30.71	3.31	-1.69	5.60
	- 2	1.88	33.43	3.79	0.26	10.63
#4	D09317-S1	1.82	31.46	6.81	-0.59	6.70
	-S2	1.93	34.12	5.22	-1.20	7.29
	-S3	1.92	30.59	5.04	-0.45	5.31
	-S4	1.83	30.51	5.55	-1.35	5.13
	-S5	1.77	32.91	5.18	-0.09	3.18
	-S6	1.87	33.23	5.86	-0.57	3.32
#5	D09338- 1	1.93	34.21	6.54	0.26	4.35
	- 2	1.98	34.05	6.10	-0.50	7.70
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<u>FM 5839</u>		RESIDUAL VOLATILES %	RESIN CONTENT %	ACETONE EXTRACTION %	C.T.E. WITH PLY uin/in °F	C.T.E. CROSS PLY uin/in °F
GRAND TOTAL		CURED	PYROLYSIS	CURED		
		%	%	%		
AVERAGE		1.76	32.24	5.17	-0.63	6.88
STD DEV		0.23	1.55	1.00	0.72	3.95
MINIMUM		1.19	30.30	3.31	-1.81	3.14
MAXIMUM		1.98	34.21	6.81	0.49	16.44
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LOT						
#2	D09281- 1	2.38	38.57	6.33	1.18	6.95
REJECT	- 2	2.51	40.13	6.20	0.34	5.43
AVERAGE		2.44	39.35	6.27	0.76	6.19

FM 5839 CURED PANEL
LOT AVERAGES AND STATISTICAL SUMMARY

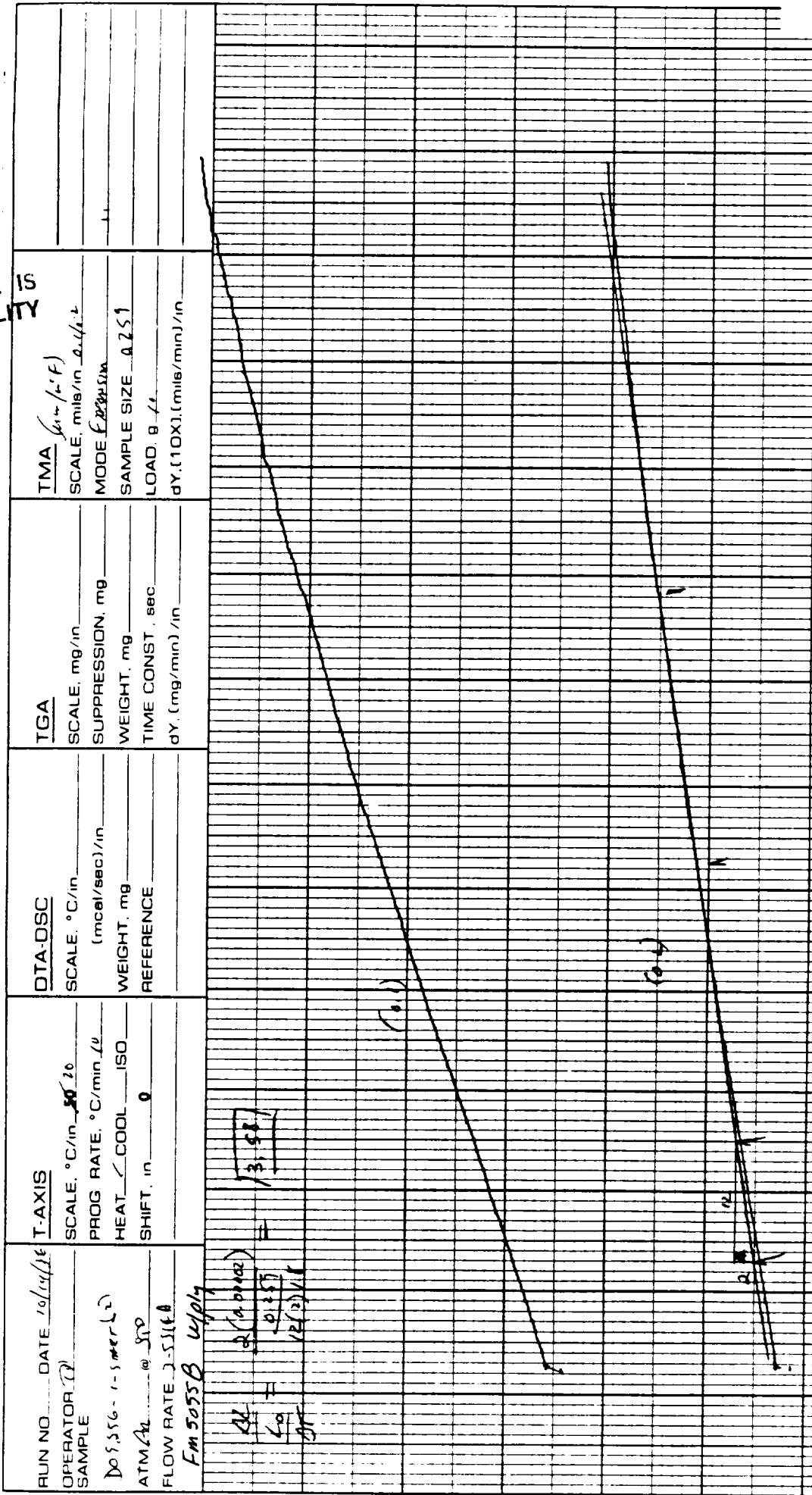
NAS8-36298

LOT AVERAGES	RESIDUAL VOLATILES %	RESIN CONTENT %	ACETONE EXTRACTION %	C.T.E. WITH PLY uin/in °F	C.T.E. CROSS PLY uin/in °F
LOT #1	1.65	30.97	4.39	-1.12	14.71
LOT #2	1.28	32.09	5.09	-0.32	3.87
LOT #3	1.82	32.07	3.55	-0.72	8.11
LOT #4	1.86	32.14	5.61	-0.71	5.15
LOT #5	1.96	34.13	6.32	-0.12	6.02
<hr/>					
FM 5839 GRAND AVG.	1.76	32.24	5.17	-0.63	6.88
STD DEV	0.23	1.55	1.00	0.72	3.95
COUNT	14	14	14	14	14
A BASIS FACTOR	3.585	3.585	3.585	3.585	3.585
A BASIS MINIMUM	0.93	26.69	1.57	-3.22	-7.27
A BASIS MAXIMUM	2.58	37.78	8.77	1.96	21.03

(NOTE: TOTALS DO NOT INCLUDE LOT #2 REJECT)

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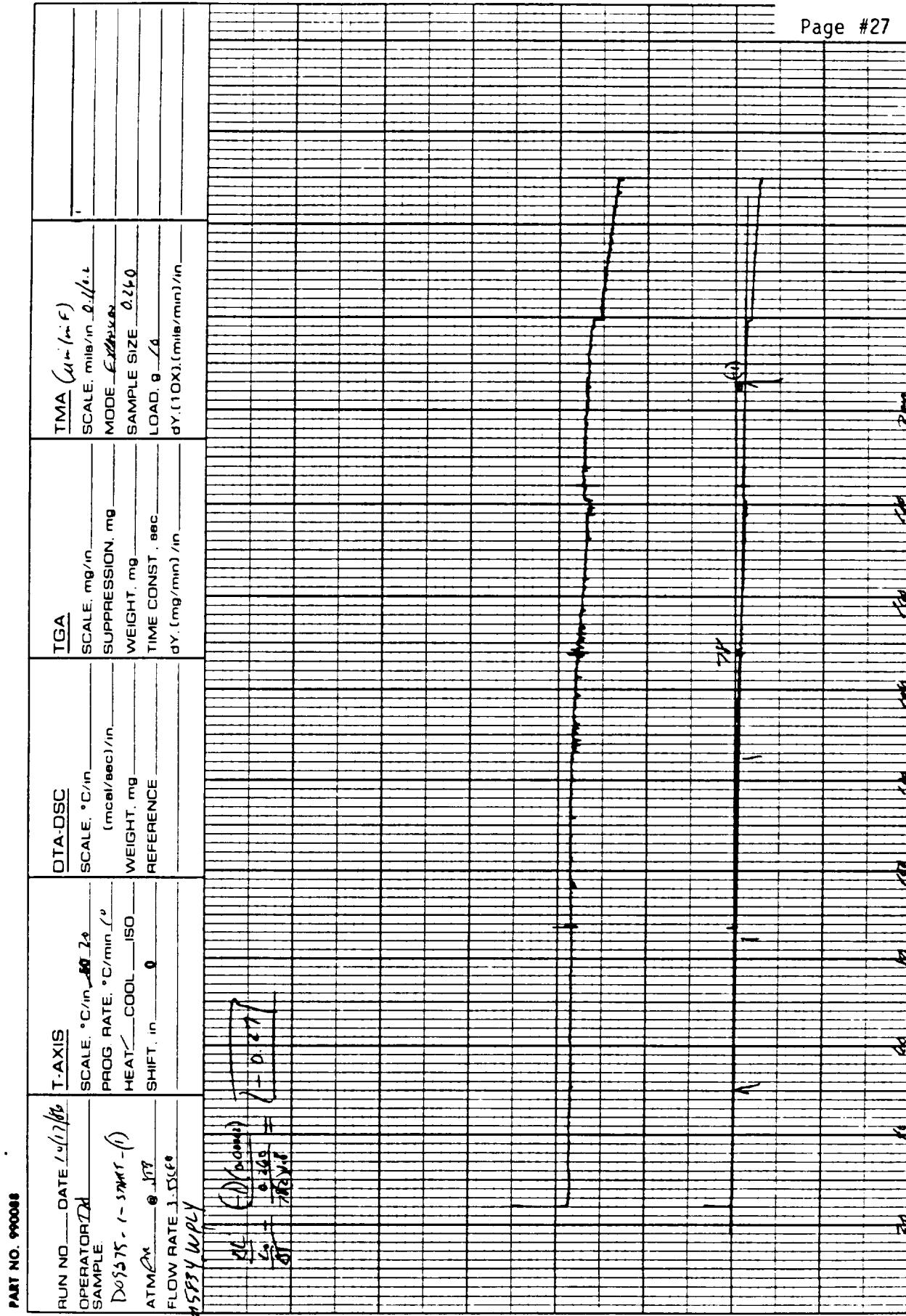


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PART NO. 990088

T-AXIS		OTA-DSC		TGA		TMA	
RUN NO	DATE	SCALE. °C/in	SCALE. °C/in	SCALE. mg/in	SCALE. mils/in	RATE	UNIT
Operator	2	PROG. RATE. °C/min	50	SUPPRESSION. mg	0.1/6+		
Sample	D61256 - 1-1904 - (3)	HEAT / COOL	160	WEIGHT. mg	0.132		
ATM	Atm	SHIFT. in	0	TIME CONST. sec	LOAD. g	10	
FLOW RATE	3.5566	REFERENCE		dY. (mg/min) /in	dY. (10X). (mils/min) /in		
Fm 55558 X P1							



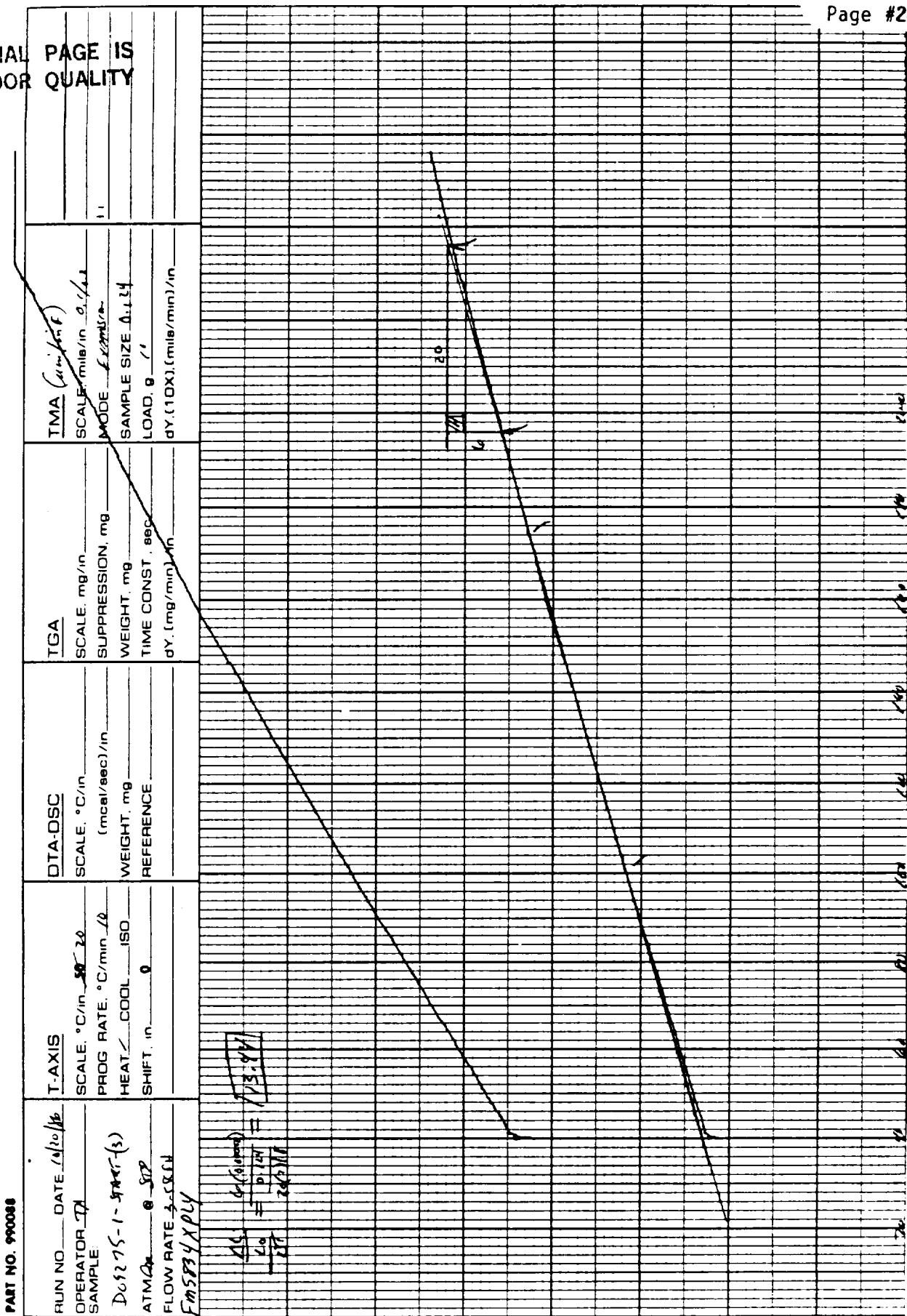


DU PONT Instruments

MEASURED VARIABLE

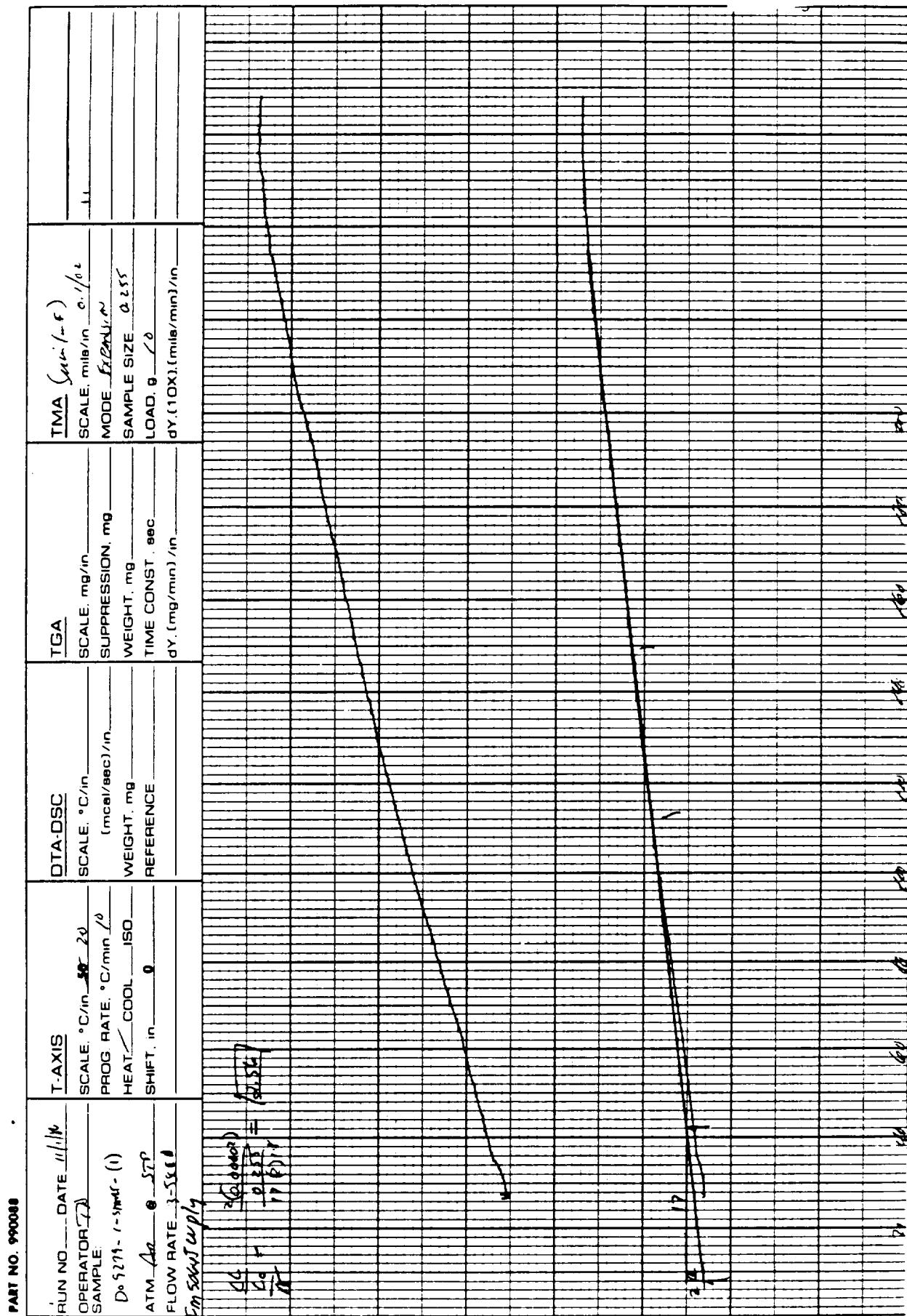
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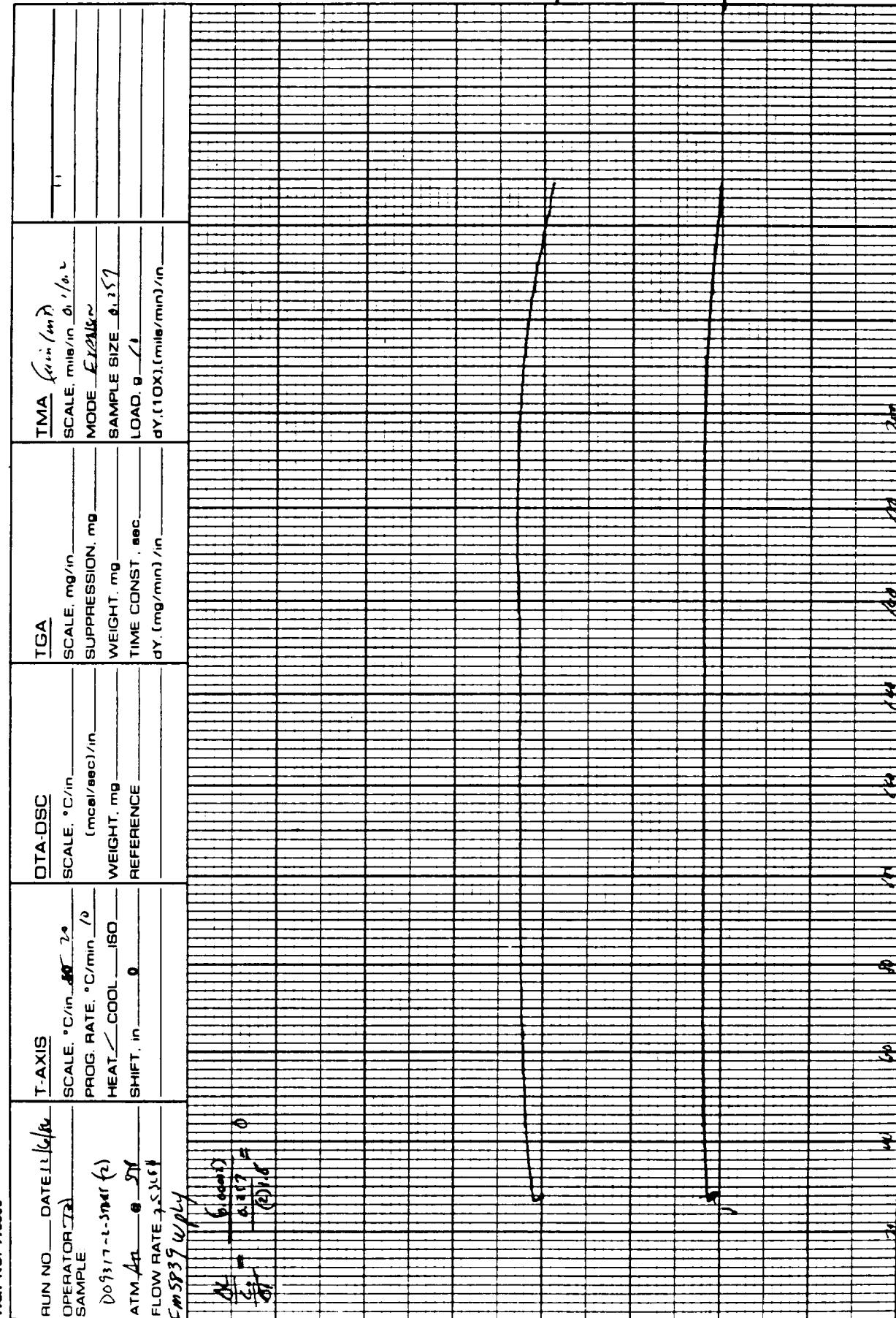
RUN NO.	DATE	T-AXIS	DTA-DSC	TGA	TMA
4446	12/16/86	SCALE, °C/in <u>20</u>	SCALE, °C/in <u>20</u>	SCALE, mg/in <u>0.1</u>	SCALE, mils/in <u>0.1</u>
OPERATOR	<u>JMK</u>	PROG. RATE, °C/min <u>10</u>	(mg/sec)/in	SUPPRESSION, mg	MODE <u>EC2048</u>
SAMPLE	D52179-1-JMKE - 4	HEAT <u>/</u> COOL <u>ISO</u>	WEIGHT, mg	WEIGHT, mg	SAMPLE SIZE <u>.2124</u>
ATM	<u>Atm</u> <u>STOP</u>	SHIFT, in <u>0</u>	REFERENCE	TIME CONST, sec	LOAD, g <u>44</u>
FLOW RATE	3.5cc/l			dY, (mg/min) /in	dY, (110X), (mils/min) /in
Flow rate 3.5cc/l Film sample Xply					

PANTONO

DUPONT INSTRUMENTS

MEASURED VARIABLE
ORIGINAL DATE 1983
ON YEAR QUARTER

PART NO. 990048



DUPOUNT Instruments

MEASURED VARIABLE

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PART NO. 990008

T-AXIS		DTA-OSC		TGA		TMA	
RUN NO.	DATE 12/4/81	SCALE °C/in	SCALE °C/min	SCALE mg/in	SUPPRESSION mg	SCALE mil/in	SCALE mil/in
OPERATOR [D]		PROG RATE. °C/min	10	WEIGHT. mg		MODE	SPAN 500mV
SAMPLE		HEAT / COOL	150	REFERENCE		SAMPLE SIZE	0.1g
D61317-2 - STAR-(3)		SHIFT. in	0			LOAD. g	10
ATM 0.0 0.5T						dY (10X) (mg/min)/in	
FLOW RATE 2.55(cc)							
Lms5839 Xpdy							

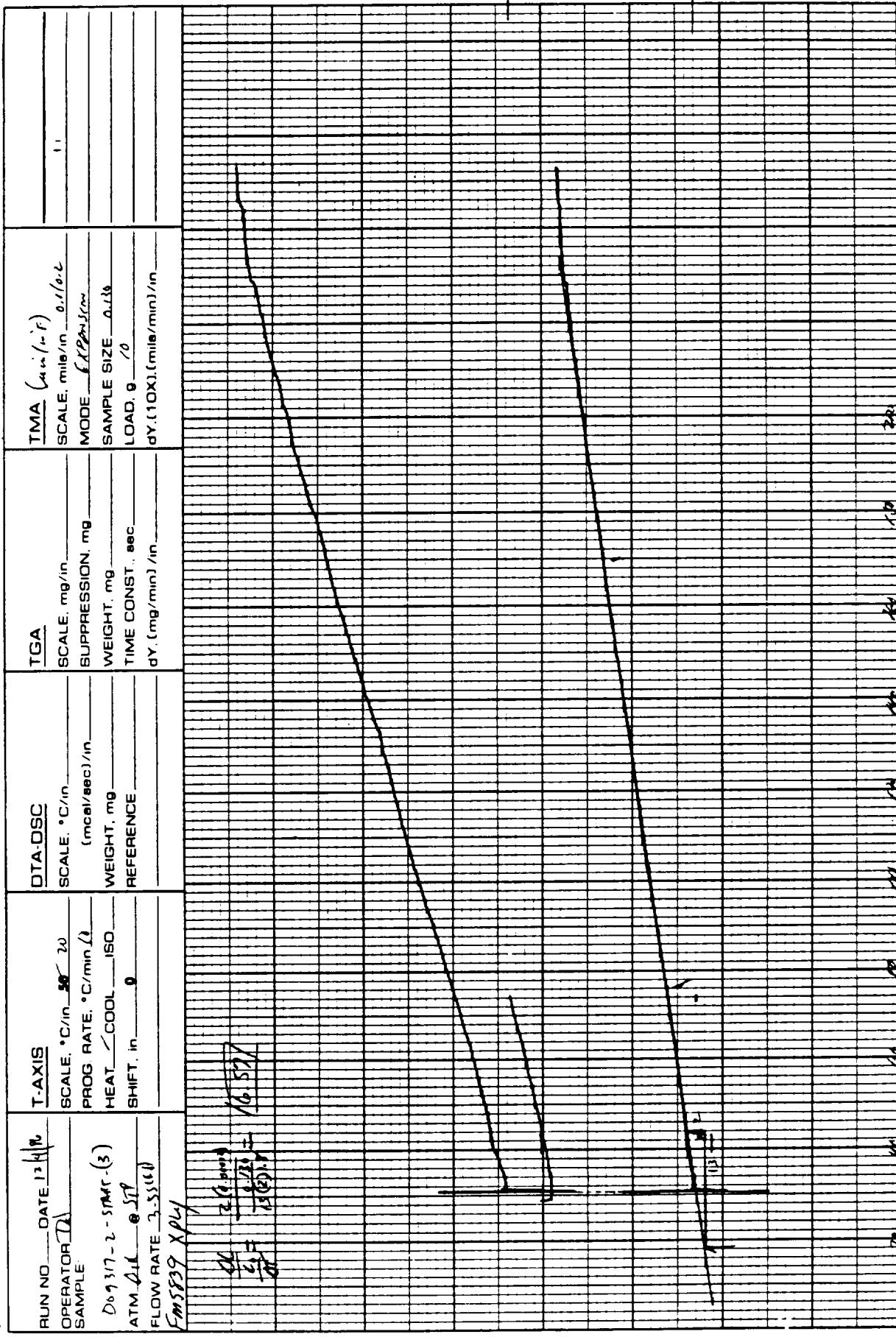


TABLE OF CONTENTS

SHELF LIFE STUDY

NAS8-36298

U.S. Polymeric O.E. 71108

	<u>PAGE</u>
I. SAMPLING PLAN.....	1
II. TEST RESULTS.....	2
III. SUMMARY.....	3

TABLES AND CHARTS

Comparative Charts - Volatiles.....	5
Comparative Charts - Wet Flow.....	7
FM 5055B Percent Volatiles.....	9
FM 5834 Percent Volatiles.....	11
FM 5064J Percent Volatiles.....	13
FM 5839 Percent Volatiles.....	15
FM 5055B Wet Flow.....	17
FM 5834 Wet Flow.....	19
FM 5064J Wet Flow.....	21
FM 5839 Wet Flow.....	23
FM 5055B Shelf Life Data.....	25
FM 5834 Shelf Life Data.....	26
FM 5064J Shelf Life Data.....	27
FM 5839 Shelf Life Data.....	28

SHELF LIFE STUDY

COMMENTS AND OBSERVATIONS

NAS8-36298

I. SAMPLING PLAN

The balance of selected samples which were taken for cured panel testing was utilized to conduct a one-year shelf life study on volatile levels and wet flows of the uncured prepreg. Two sample rolls were taken from each lot, one of which was maintained at ambient conditions at Santa Ana, California, and the other placed in nominal 40°F refrigerated storage which in actuality was maintained closer to 32°F.

Packaging for the carbon/phenolic preps (FM5055B and FM5834) was representative of production packaging with the rolls stored in a loosely sealed 4 mil polyethylene bag with 3" cardboard cores and placed in a cardboard shipping container. The carbon/carbon prep, (FM5064J and FM5839), were placed in a MIL-B-131, Class I vapor proof bags on a 3" cardboard core, sealed and placed in a cardboard shipping carton.

Specimens were removed from each roll at 3-month intervals for a total test duration of one year. Refrigerated (40°F) samples were allowed to come to room temperature in their standard packaging for a minimum of 16 hours before specimens were removed. The volatile level was determined as the average of 3 tests as per test method PTM 17B. Wet flow was determined at either 150 psi or 1,000 psi depending on the prep type, as an average of 3 tests per test method PTM 19G. All tests (3-12 months) were run by the same technician.

II. TEST RESULTS

The following table shows the changes in percent volatile content and wet flow percentage which occurred over the one year of storage time, averaging all five lots involved in the study.

<u>PREPREG TYPE</u>	<u>SHELF LIFE CHANGES</u>			
	<u>AMBIENT STORAGE</u>		<u>40°F STORAGE</u>	
	<u>VOLATILE CONT.</u>	<u>WET FLOW</u>	<u>VOLATILE CONT.</u>	<u>WET FLOW</u>
<u>CARBON/PHENOLIC IN UNSEALED POLYETHYLENE BAGS</u>				
FM 5055B	Up 23.7%	Down 15.7%	Up 30.9%	Up 14.3%
FM 5834	Down 19.7%	Down 37.2%	Up 6.3%	Down 3.8%
<u>CARBON/CARBON IN SEALED VAPOR-PROOF BAGS</u>				
FM 5064J (HITCO)	Down 1.8%	Down 37.0%	Up 15.8%	Down 32.5%
FM 5064J (KAISER)	Up 7.6%	Down 21.6%	Up 15.7%	Down 6.6%
FM 5839	Up 11.7%	Down 12.9%	Up 22.1%	Up 31.8%

Plots have been included on pages #5 through #8 to allow comparative viewing of shelf life curves for common prepreg types. The individual charts are included on pages #9 through #24. Individual data averages have been tabulated on pages #25 through #28.

As an additional indication of changes in prepreg properties after an extended storage, tack and infrared baseline (IRZB) were conducted on the same rolls of prepreg used in the shelf life study. The prepreg had been stored for approximately 1½ years, and the average results obtained for all samples are compared to the original test results obtained on this contract.

STORAGE CHANGES IN TACK (LBS.)
1½ YEARS DURATION

<u>PREPREG TYPE</u>	<u>AMBIENT STORAGE</u>		<u>40°F STORAGE</u>	
	<u>ORIGINAL</u>	<u>1½ YEARS</u>	<u>ORIGINAL</u>	<u>1½ YEARS</u>
FM 5055B	41.8	48.4 (Up 15.8%)	42.8	47.2 (Up 10.3%)
FM 5834	36.5	57.0 (Up 56.2%)	38.2	37.2 (Down 2.6%)
FM 5064J	38.2	42.6 (Up 11.5%)	37.4	26.8 (Down 28.3%)
FM 5839	21.4	18.4 (Down 14.0%)	21.8	2.1 (Down 90.4%)

STORAGE CHANGES IN IRZB
1½ YEARS DURATION

<u>PREPREG TYPE</u>	<u>AMBIENT STORAGE</u>		<u>40°F STORAGE</u>	
	<u>ORIGINAL</u>	<u>1½ YEARS</u>	<u>ORIGINAL</u>	<u>1½ YEARS</u>
FM 5055B	1.11	1.36 (Up 22.5%)	1.12	1.25 (Up 11.6%)
FM 5834	1.10	1.33 (Up 20.9%)	1.09	1.22 (Up 11.9%)
FM 5064J	0.81	0.95 (Up 17.3%)	0.83	0.94 (Up 13.3%)
FM 5839	0.83	0.91 (Up 9.6%)	0.84	0.89 (Up 6.0%)

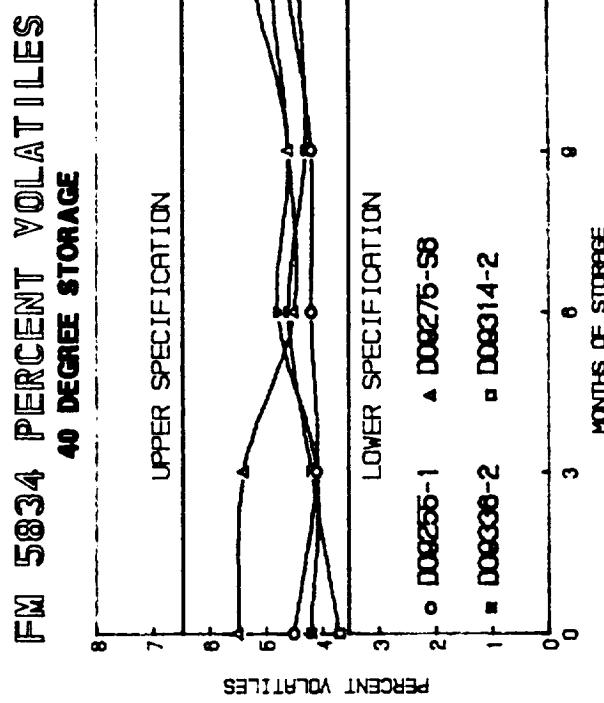
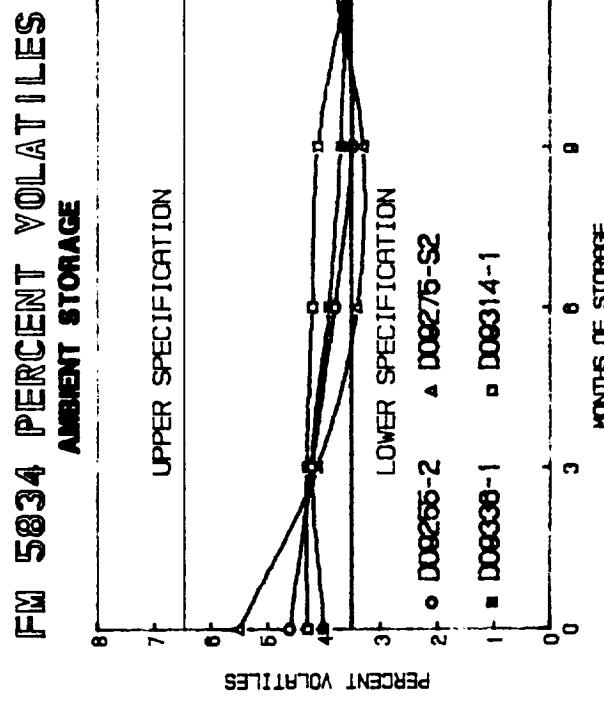
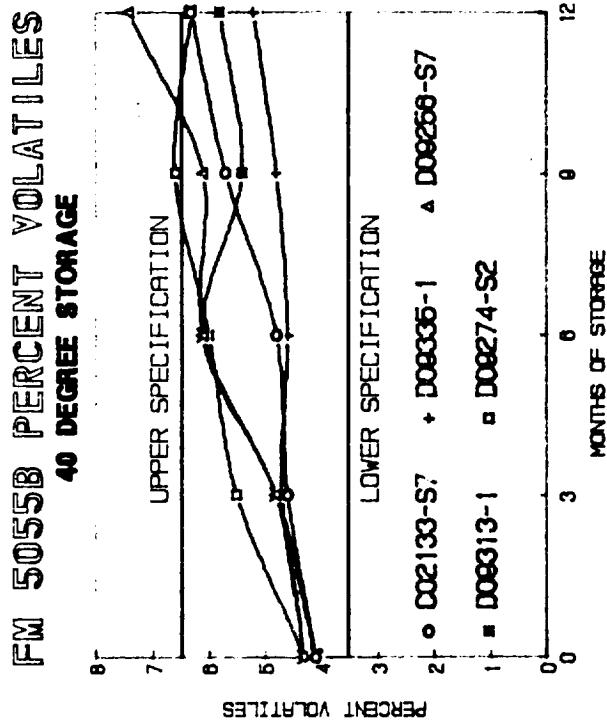
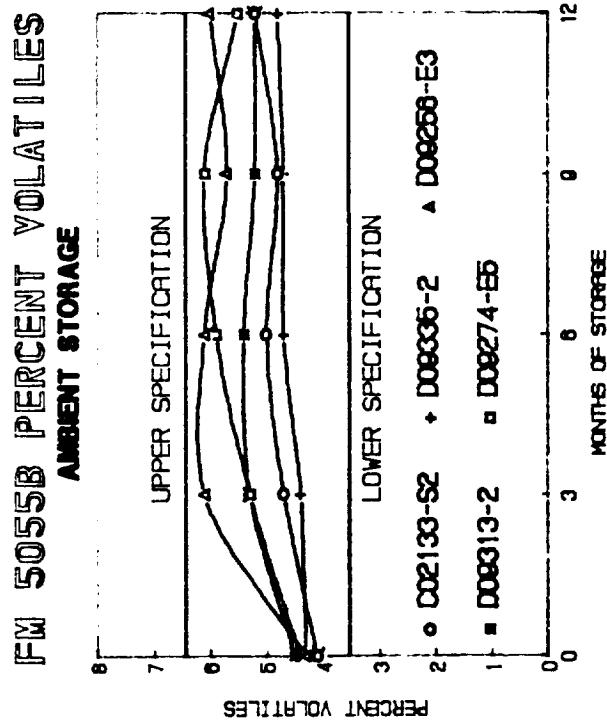
III. SUMMARY

As can be noted, the volatile level increased on all prepreg types under refrigerated storage. As samples were removed from the vapor proof bags used for the carbon/carbon preps, the resealing may not have been as complete as the original seals and the 16-hour equilibration time, where refrigerated samples were allowed to come to room temperature, may not have been sufficient.

As expected, all wet flows decreased at ambient storage conditions indicating a tendency for resin advancement even at ambient conditions. Balance of the data show mixed trends; no additional conclusions can be drawn.

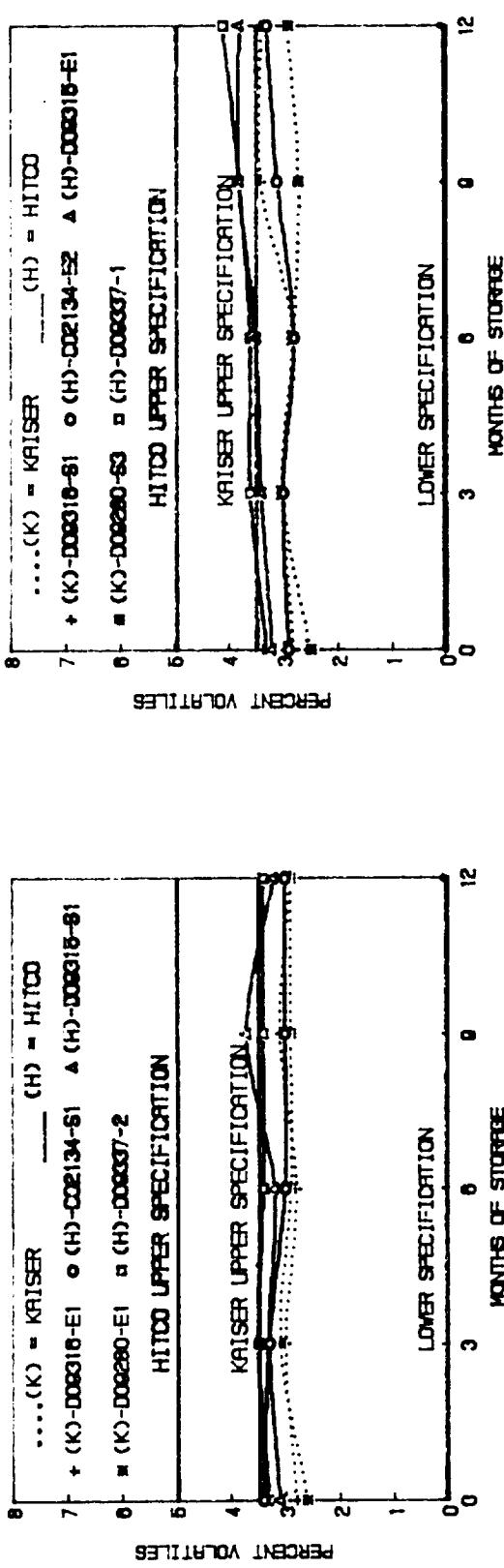
The level of tack after 1½ years at ambient storage surprisingly showed increases in all preps except FM 5839, and the tack decreased after 1½ years at 40°F storage on all prepreg except FM 5055B. The tack on FM 5839 at 40°F storage fell to essentially zero level.

The index of polymerization (IRZB) of all samples increased, demonstrating the advancement of both resin systems. As expected, the ambient storage generally had more advancement than 40°F storage. It should be noted that the IRZB for carbon/carbon prepgs with USP 39A resin should not be directly compared to 91LD resin because of the shift in the peak from 9.8 microns to 9.55 microns for USP 39A.

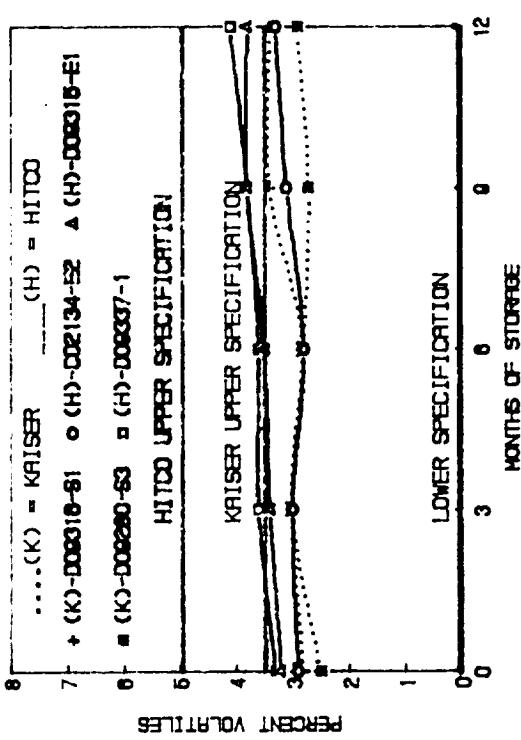


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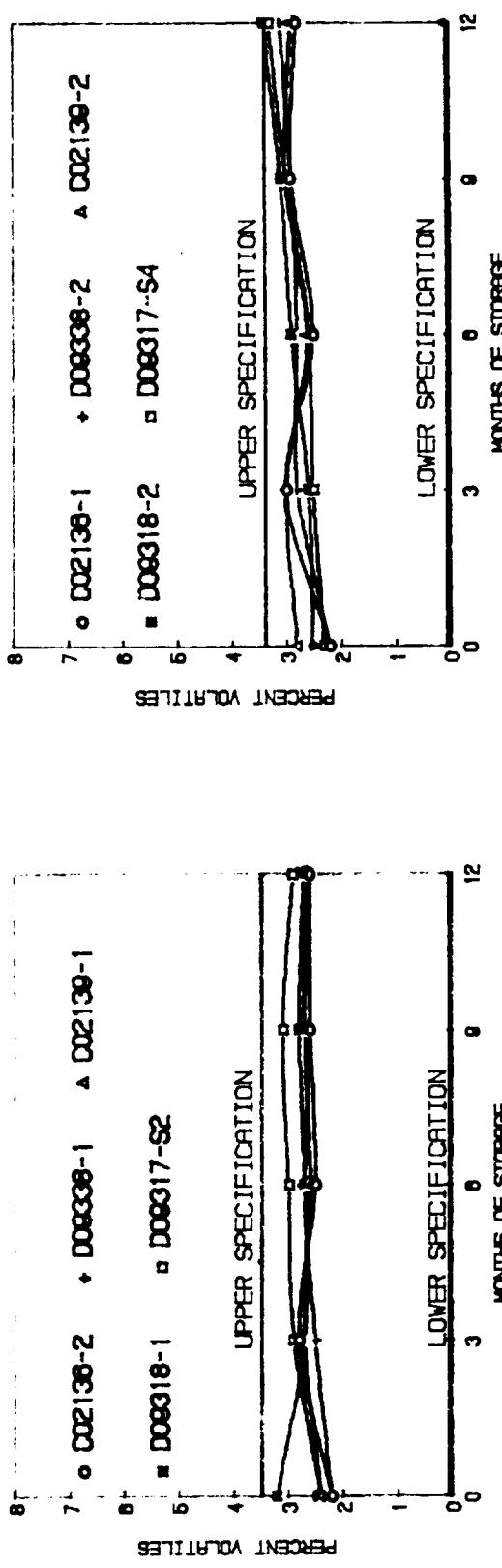
**FM 5064J PERCENT VOLATILES
AMBIENT STORAGE**



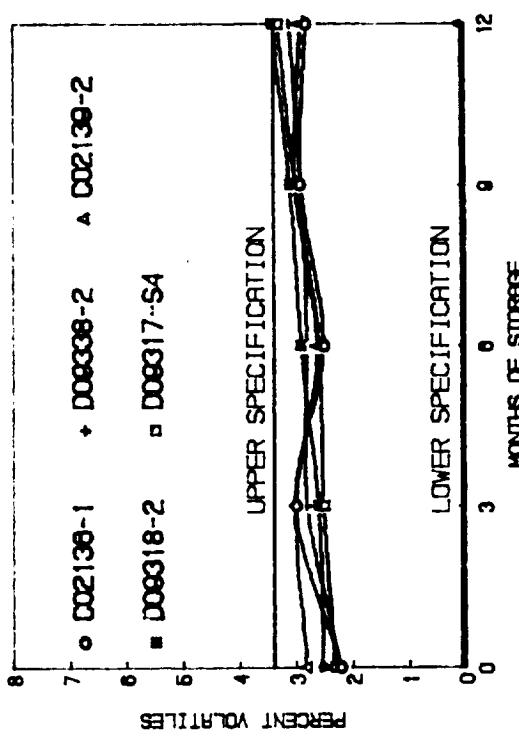
**FM 5064J PERCENT VOLATILES
40 DEGREE STORAGE**



**FM 5839 PERCENT VOLATILES
AMBIENT STORAGE**

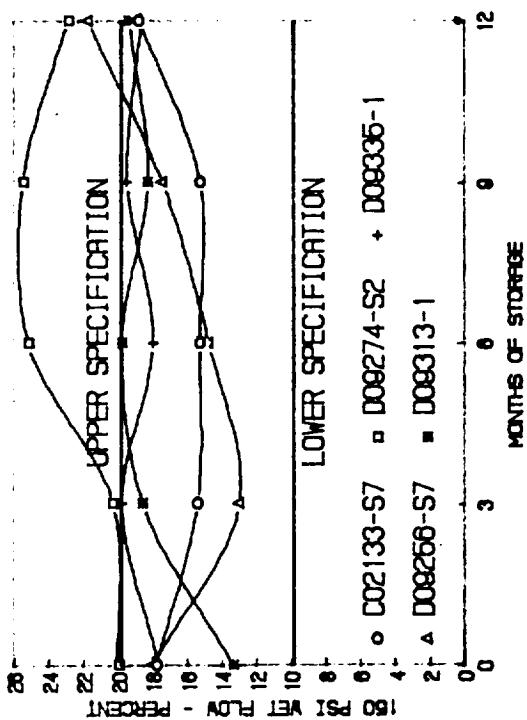


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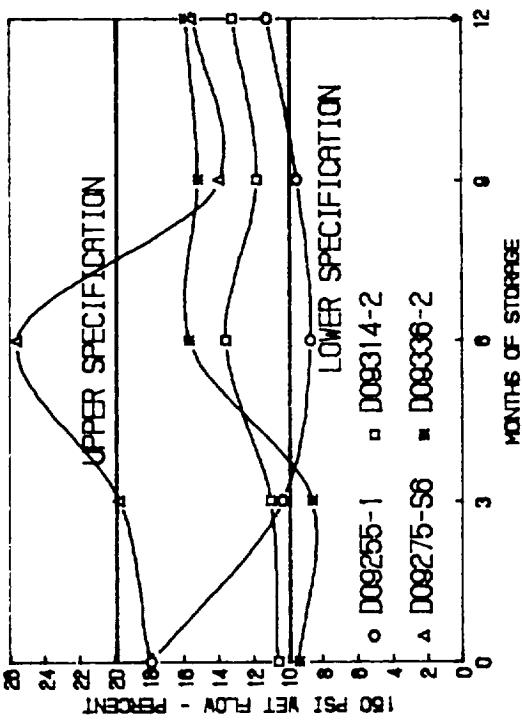


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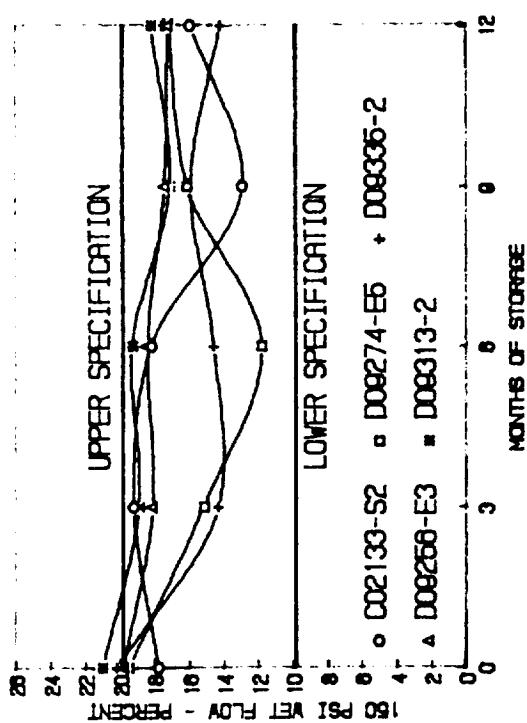
**FM 5055B WET FLOW
40 DEGREE STORAGE**



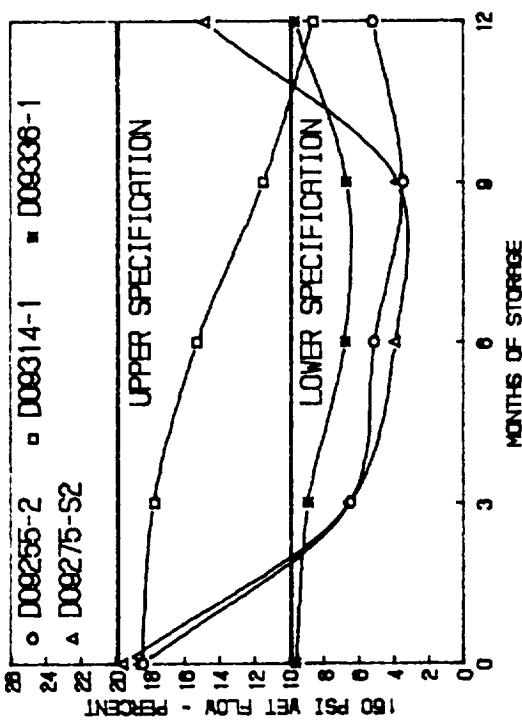
**FM 5055B WET FLOW
40 DEGREE STORAGE**

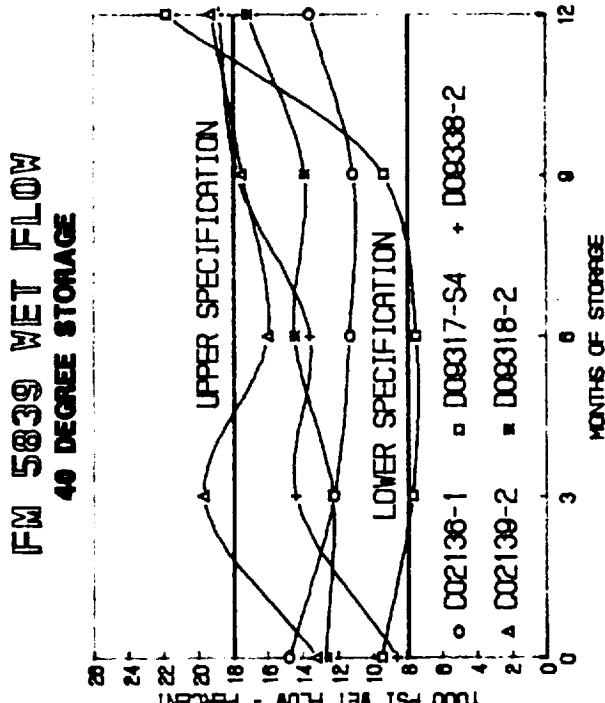
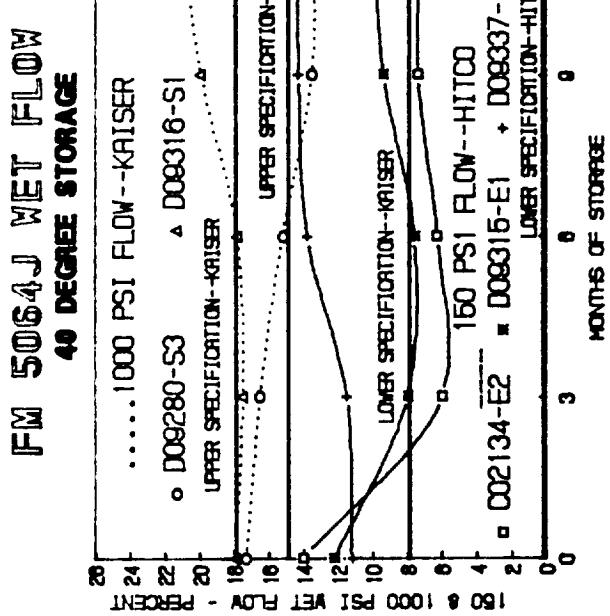
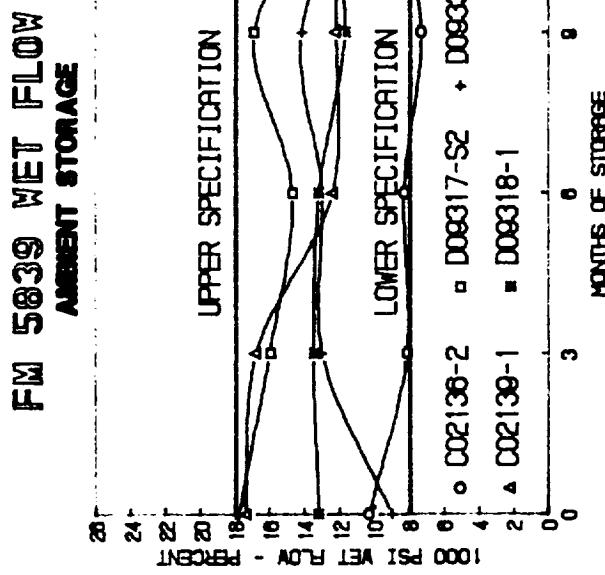
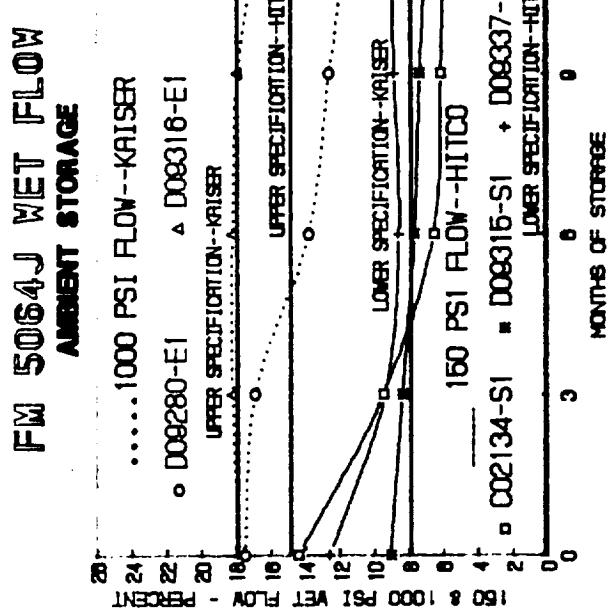


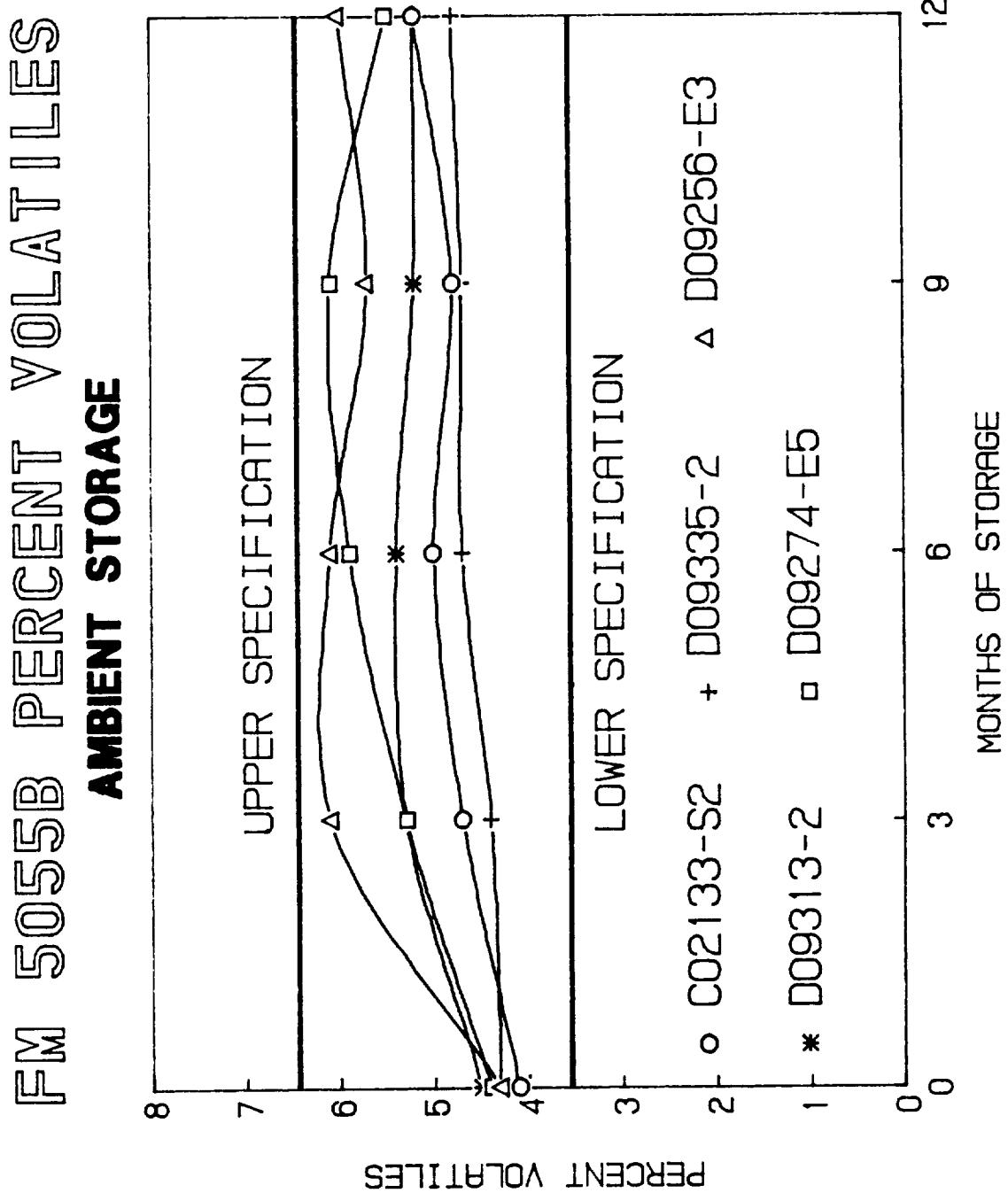
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AMBIENT STORAGE**

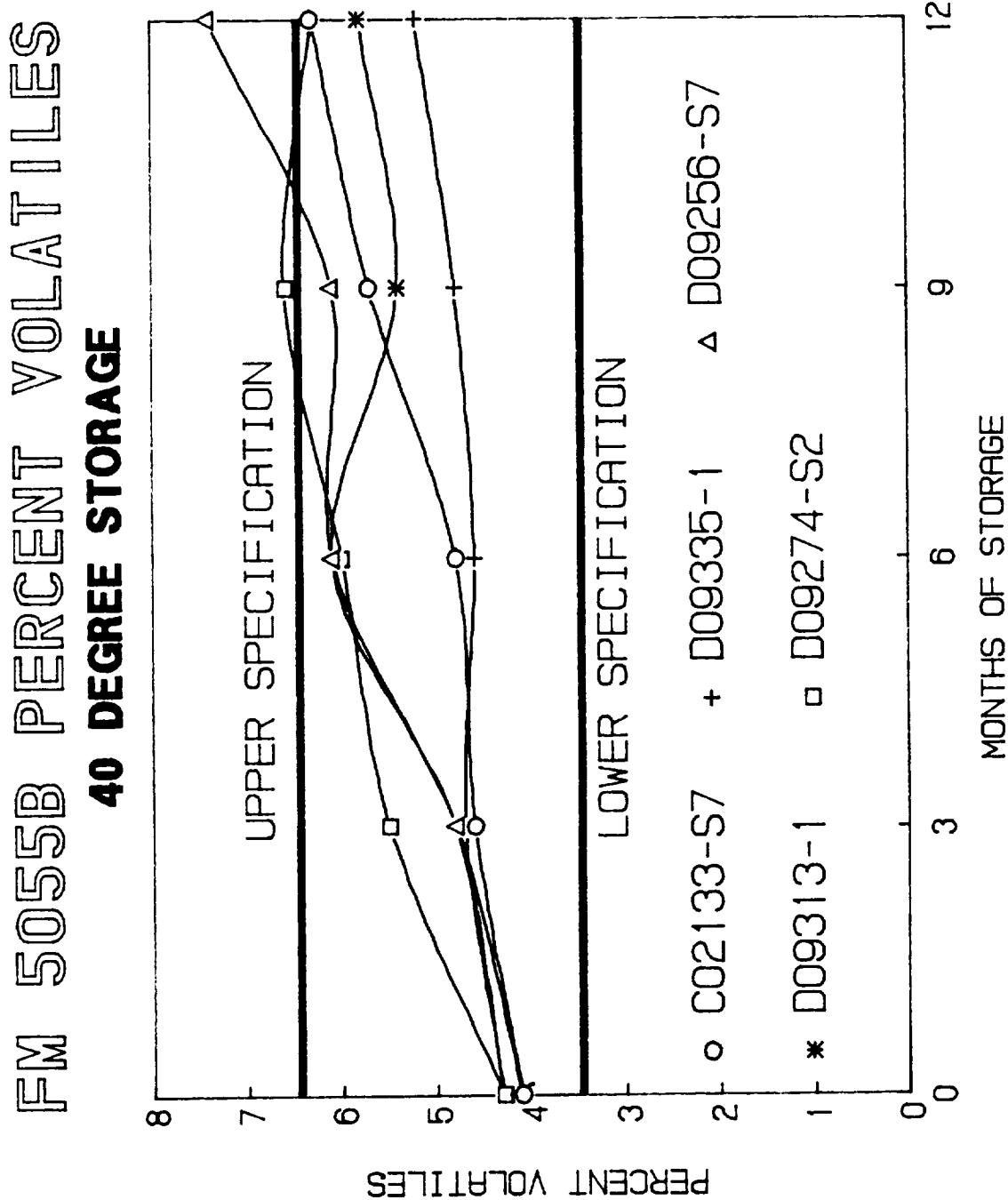


**FM 5055B WET FLOW
AMBIENT STORAGE**

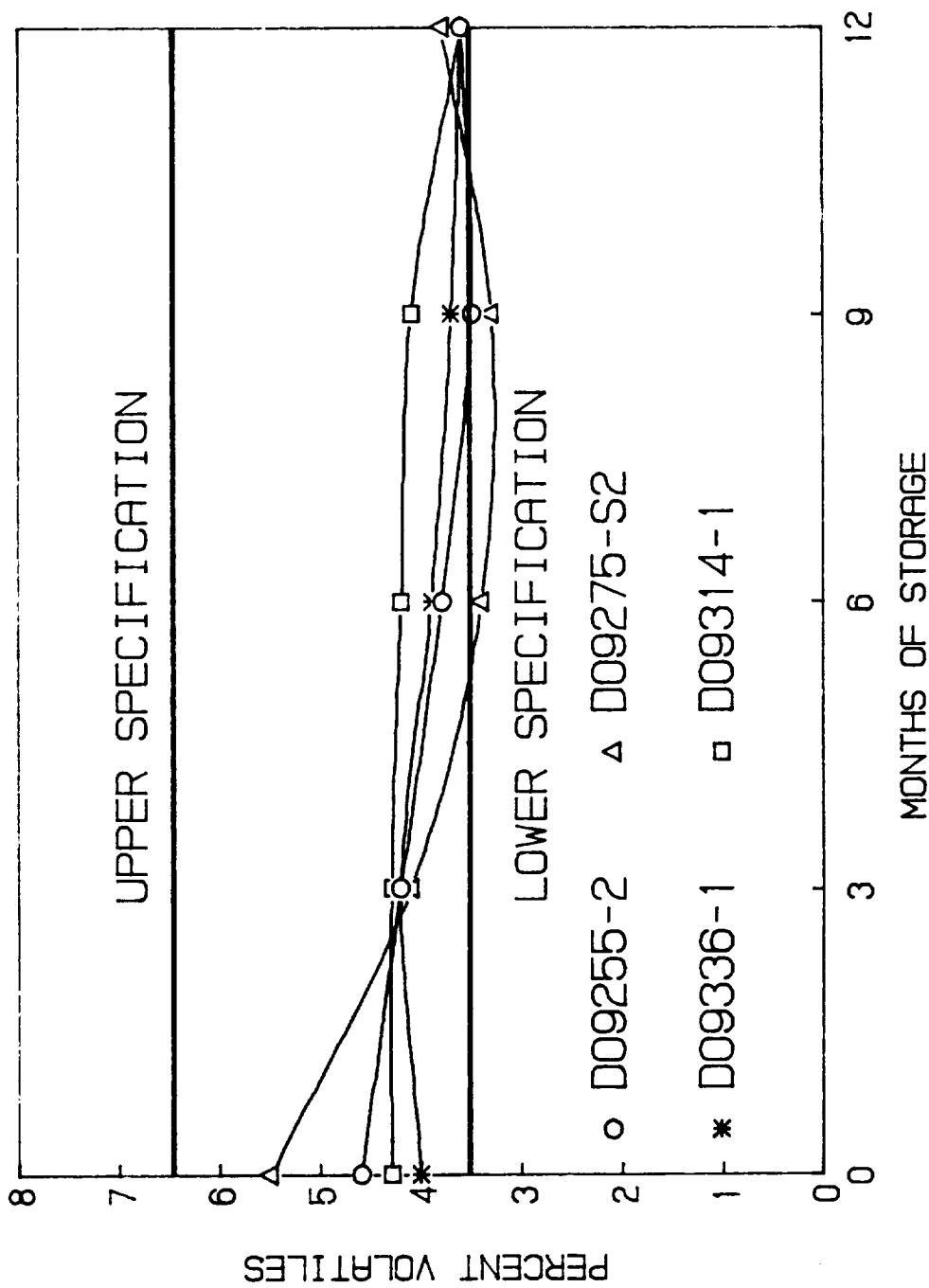




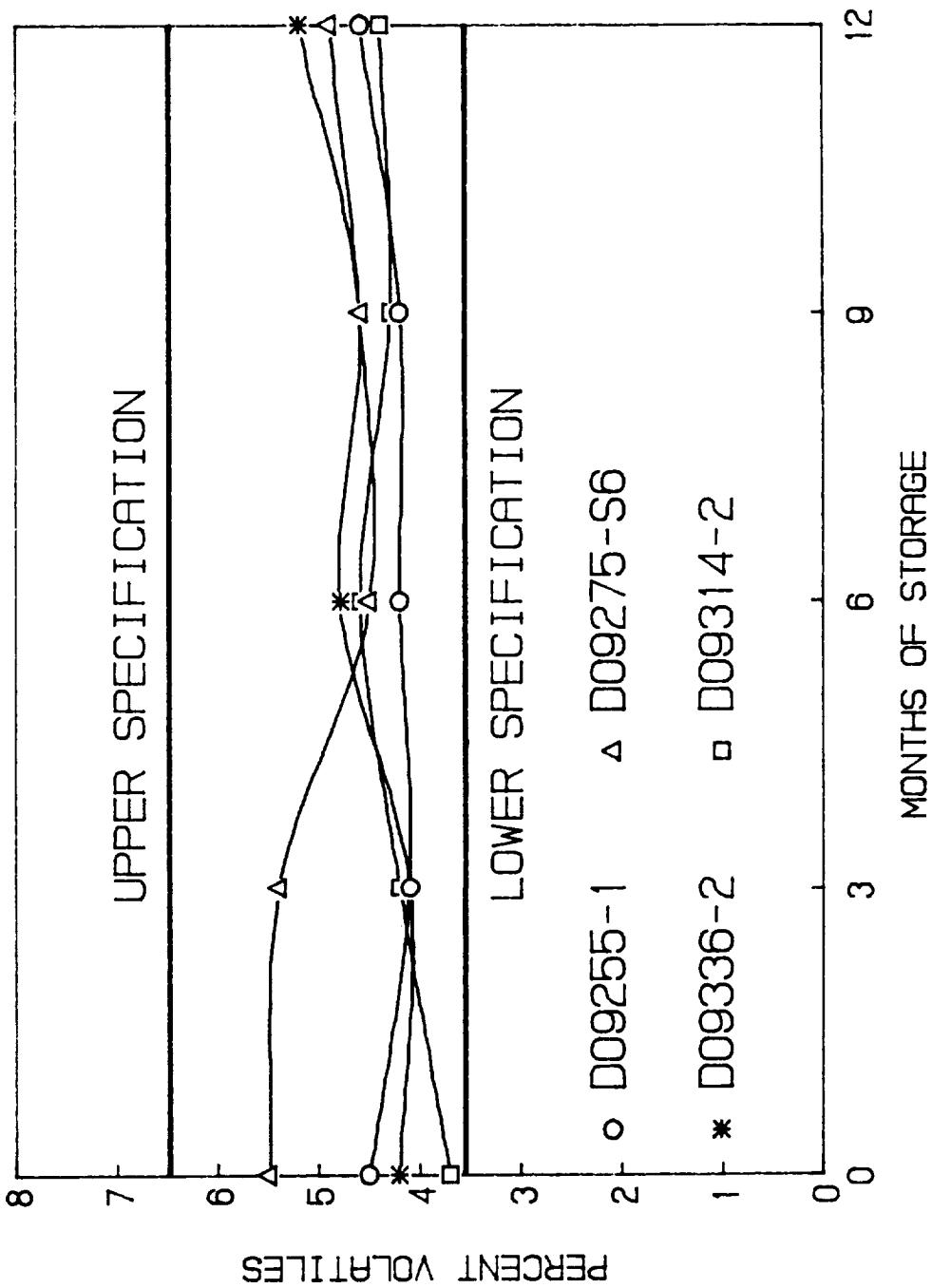




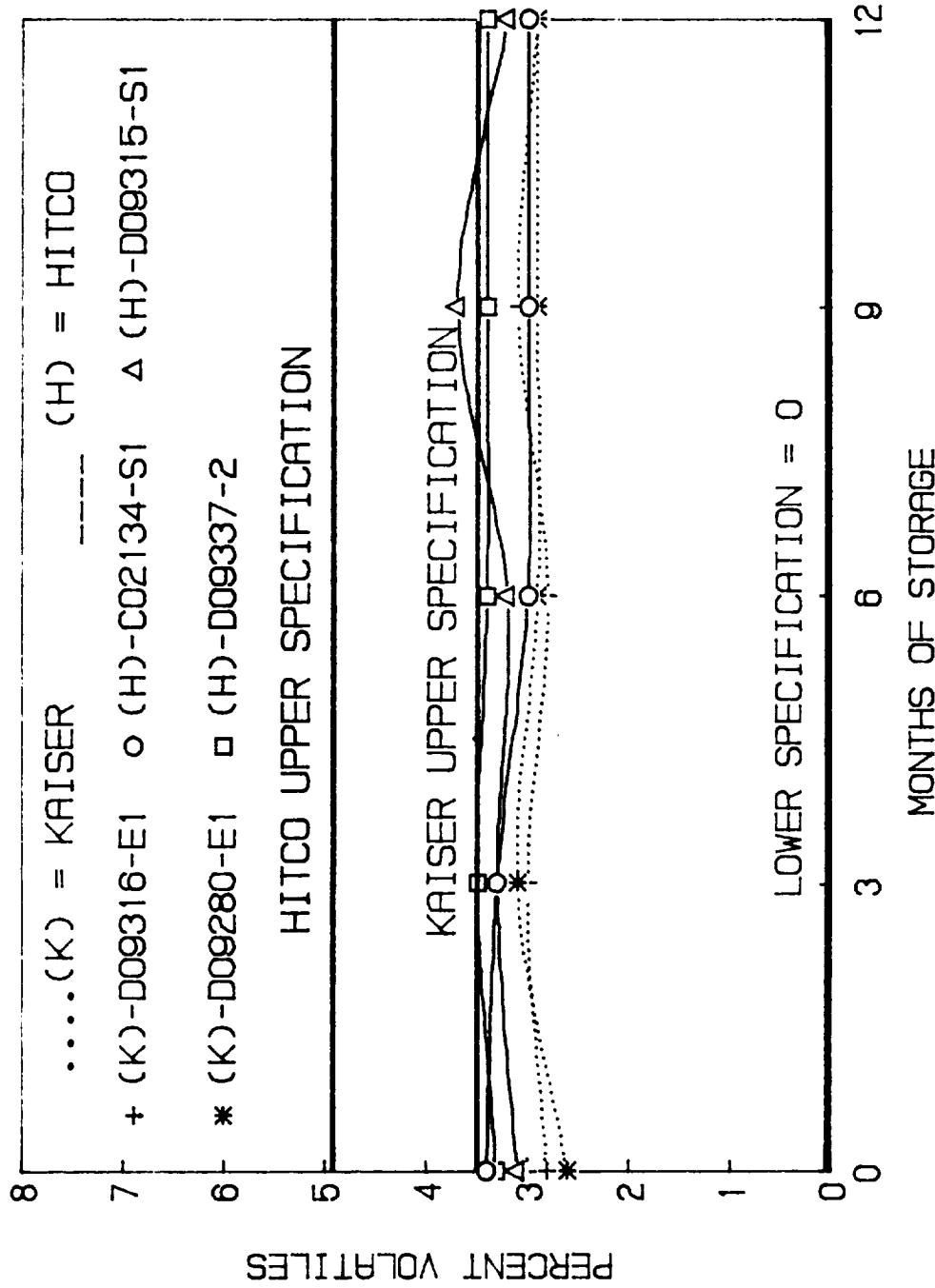
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AMBIENT STORAGE**



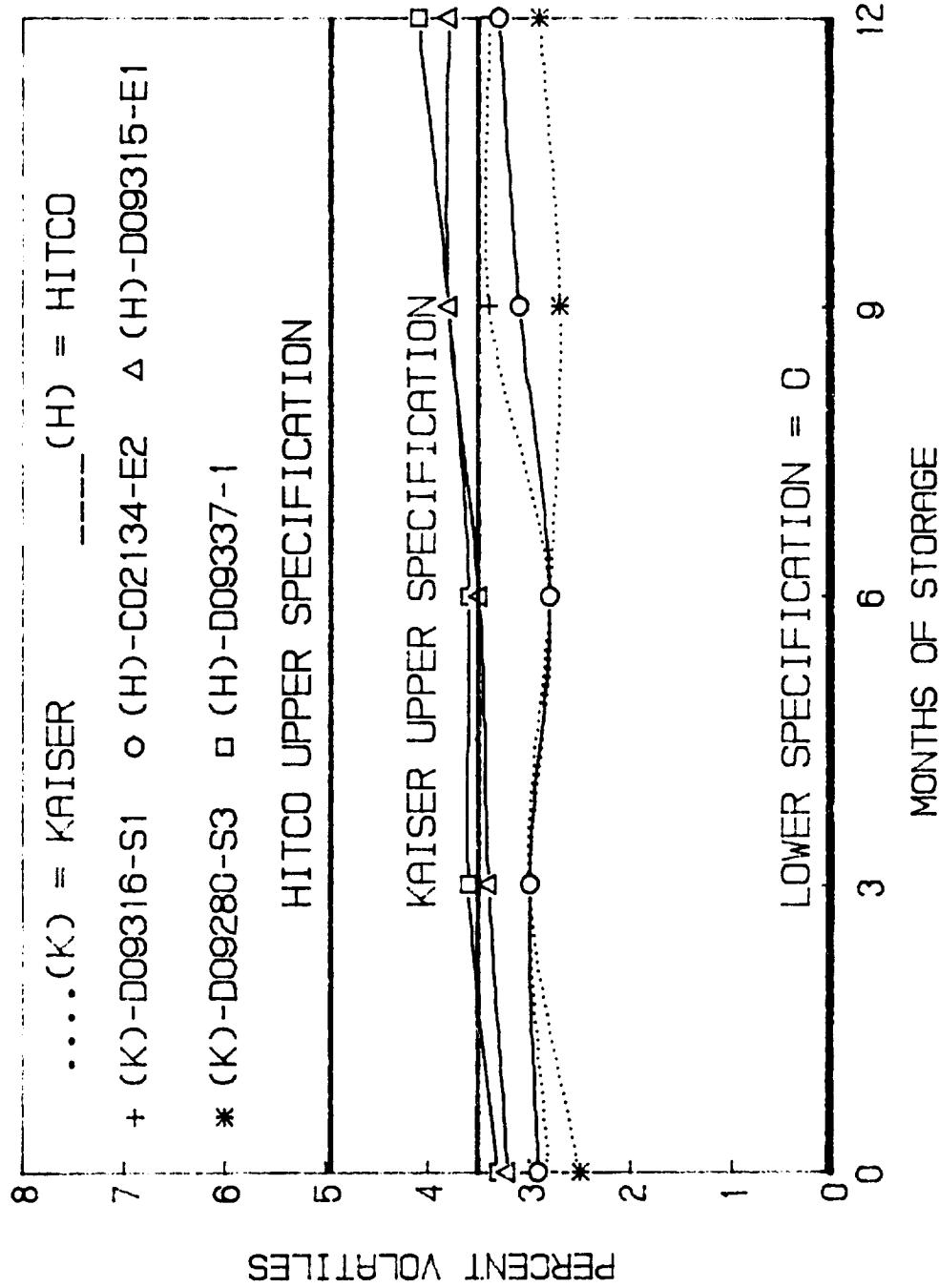
FM 5834 PERCENT VOLATILES
40 DEGREE STORAGE



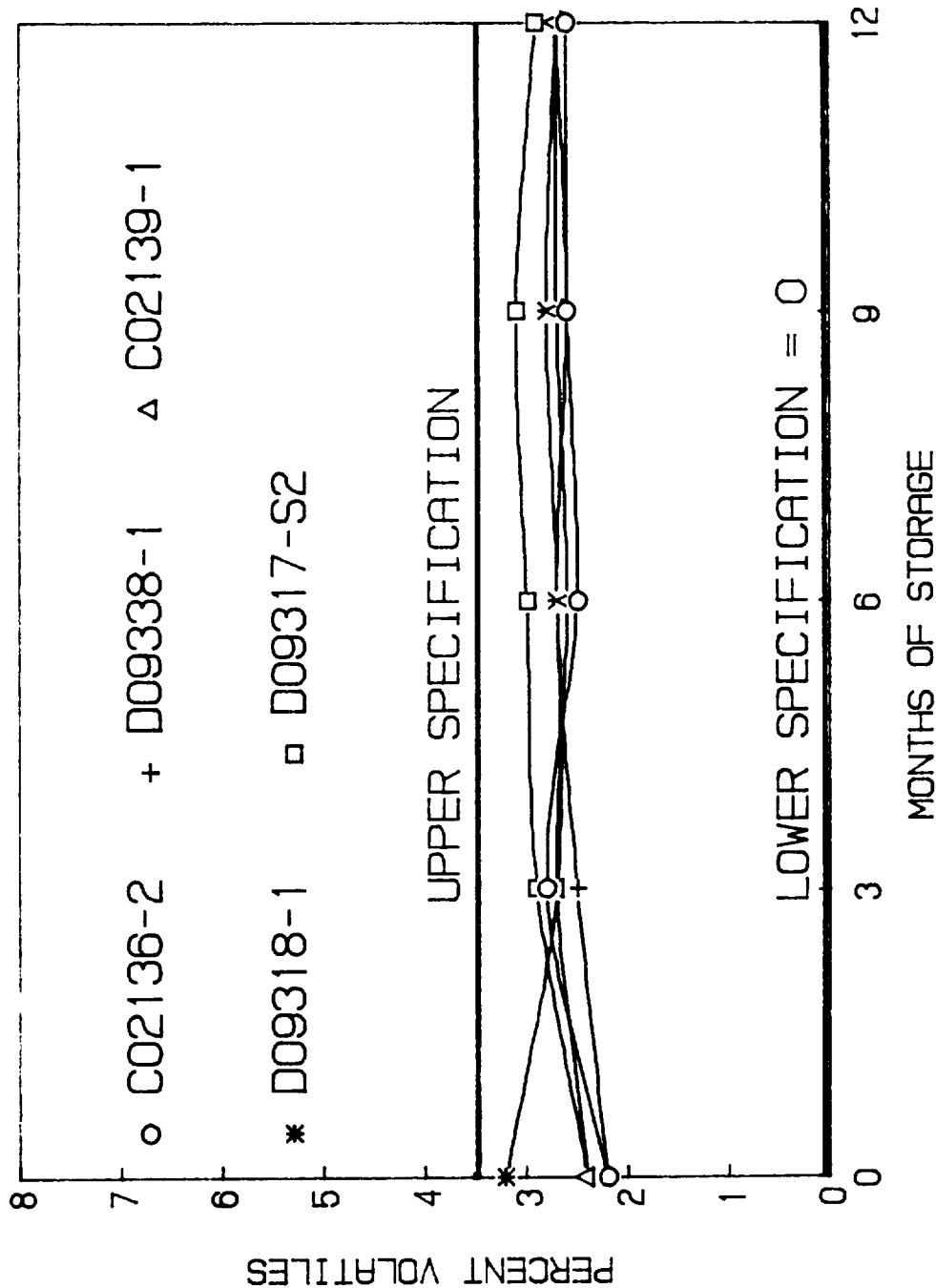
FM 5064J PERCENT VOLATILES
AMBIENT STORAGE



**FM 5064 J PERCENT VOLATILES
40 DEGREE STORAGE**

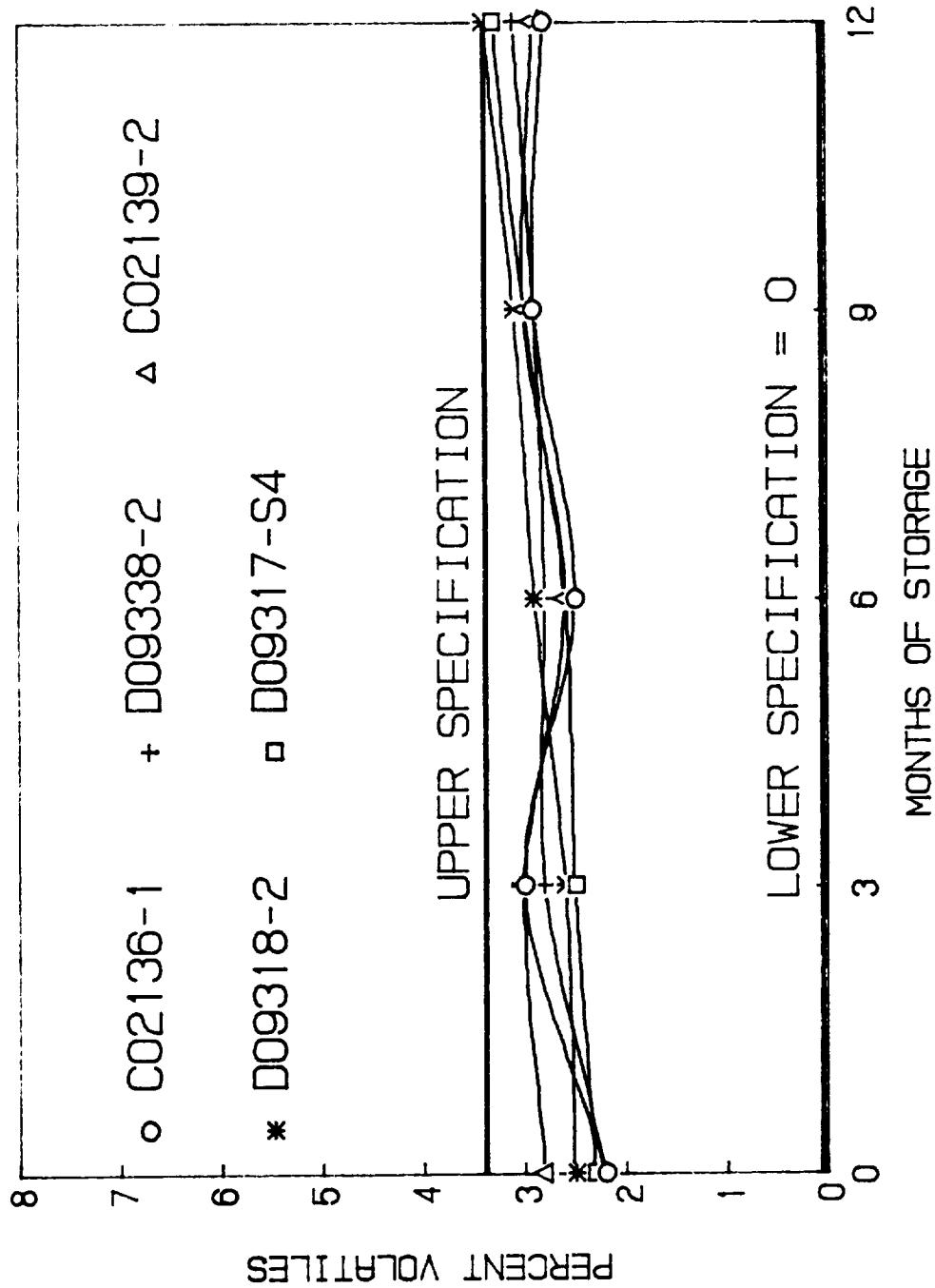


FM 5839 PERCENT VOLATILES
AMBIENT STORAGE

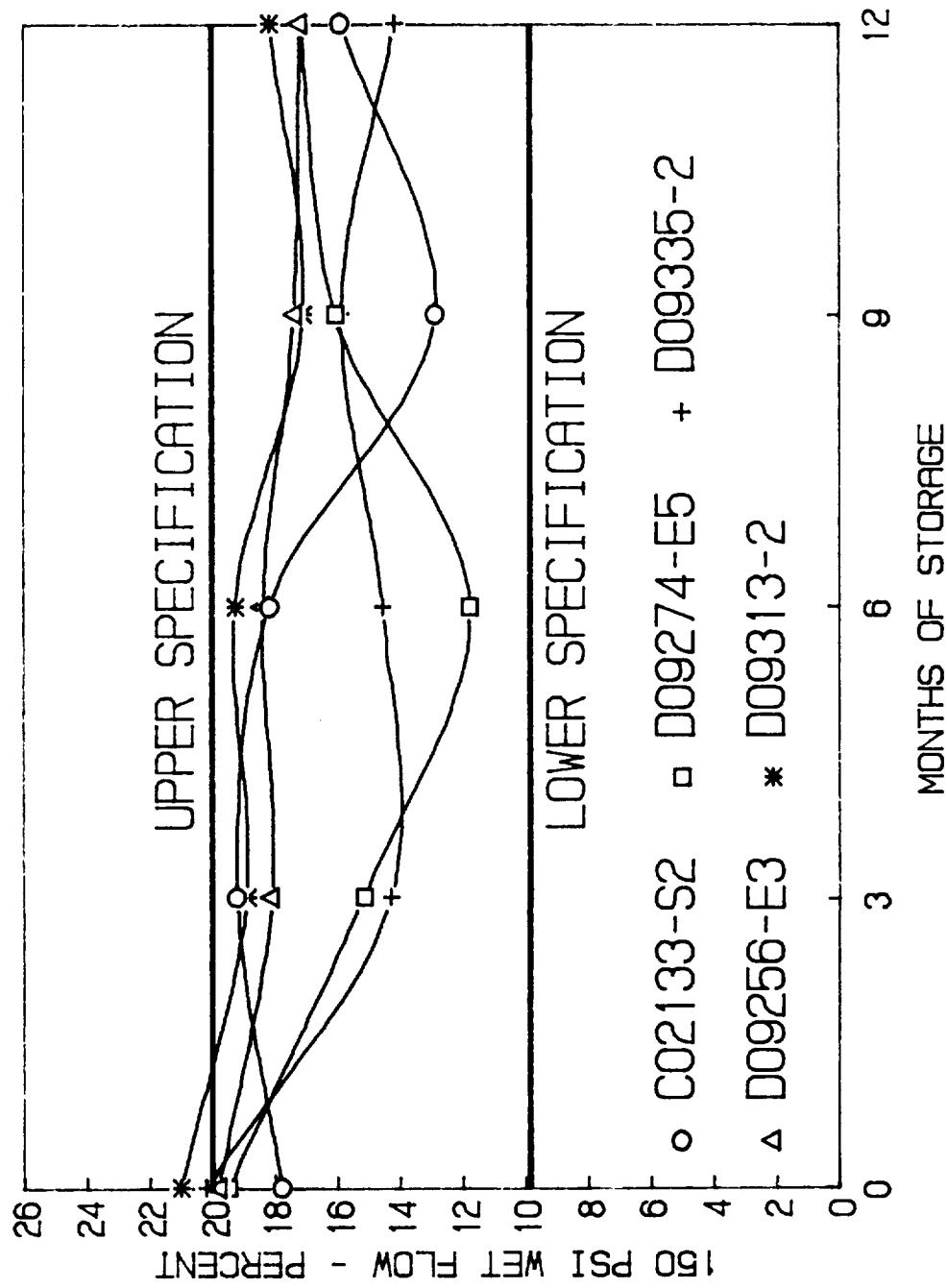


FM 5839 PERCENT VOLATILES

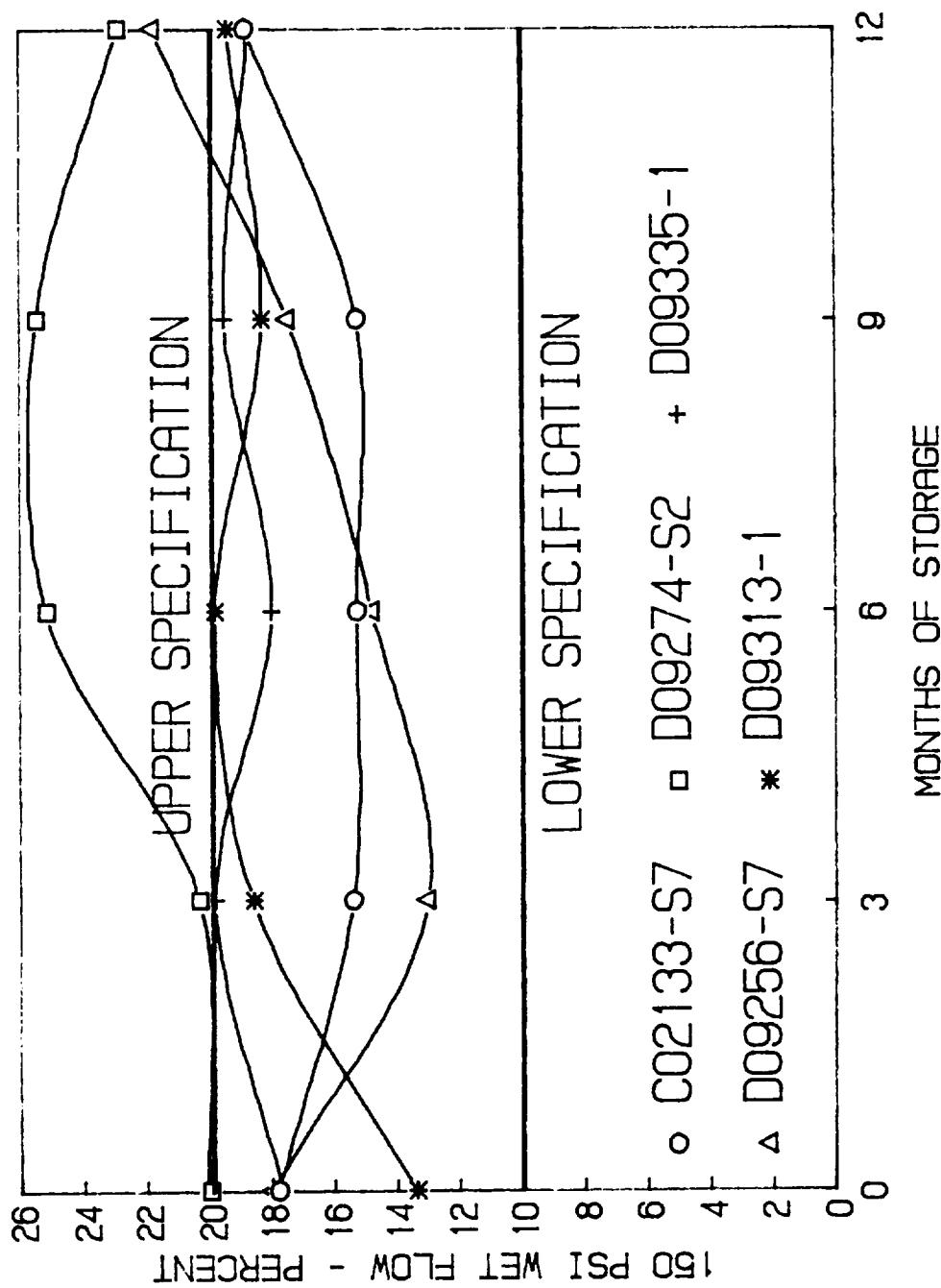
40 DEGREE STORAGE



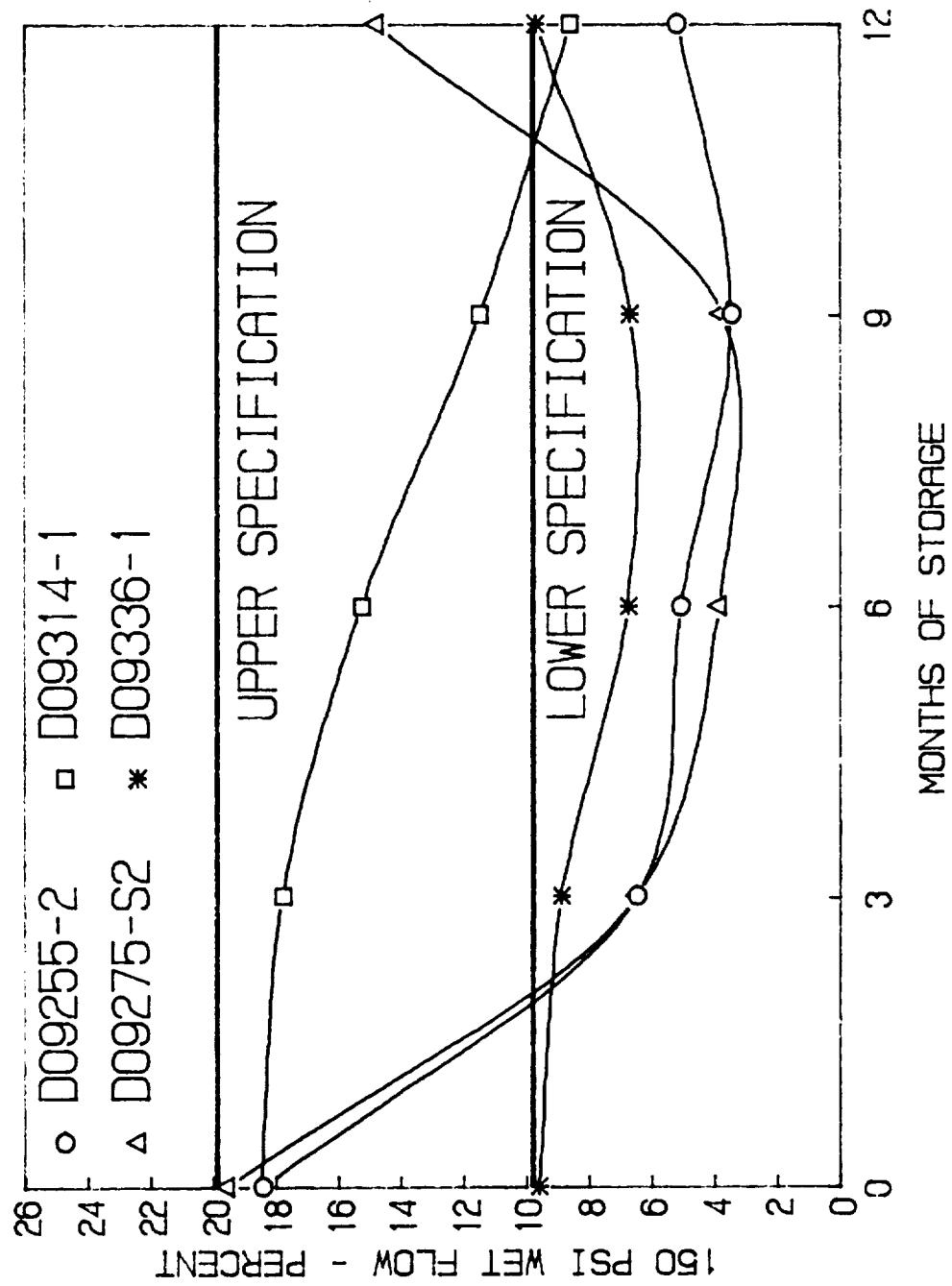
FM 5055B WET FLOW
AMBIENT STORAGE



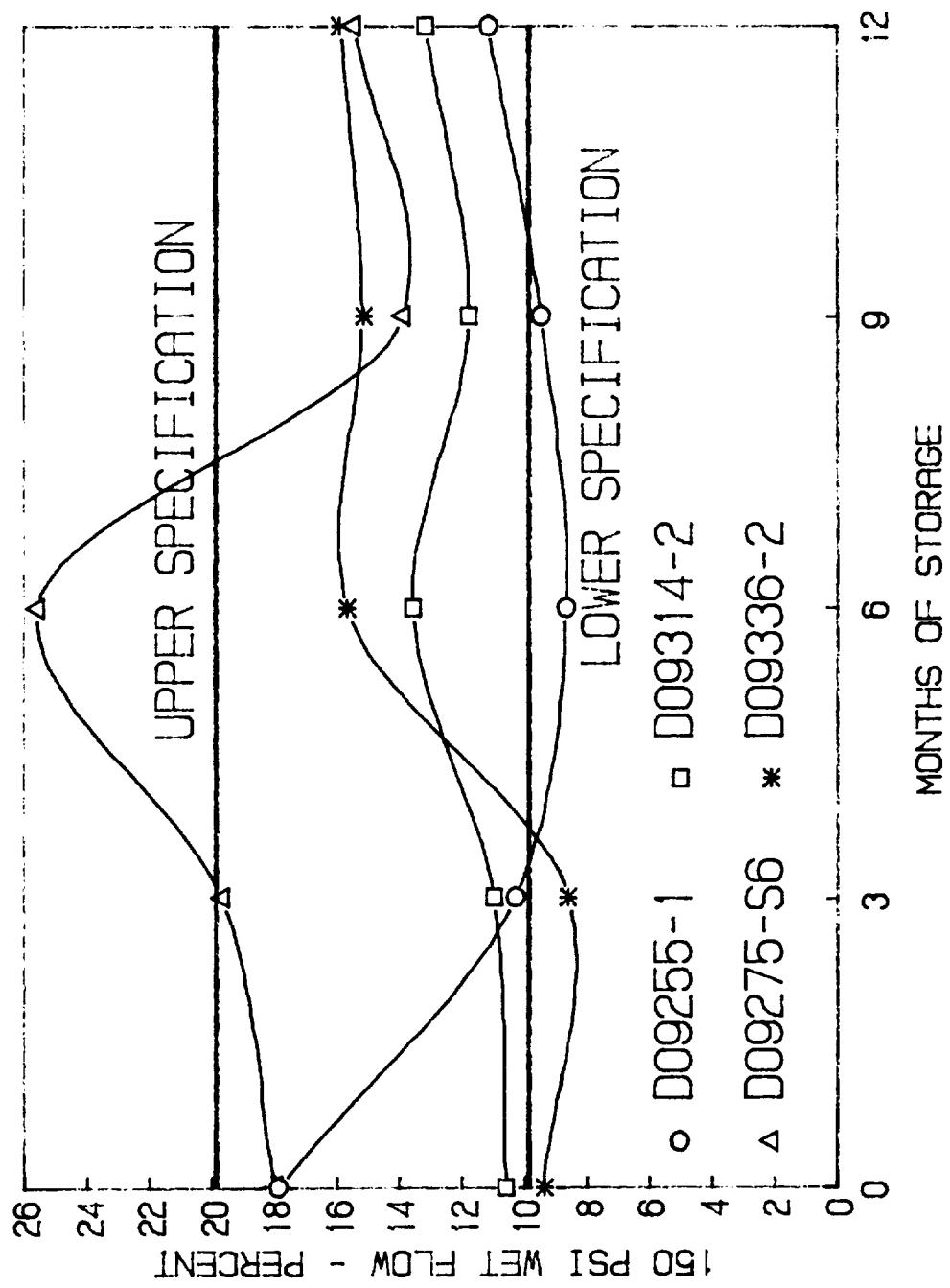
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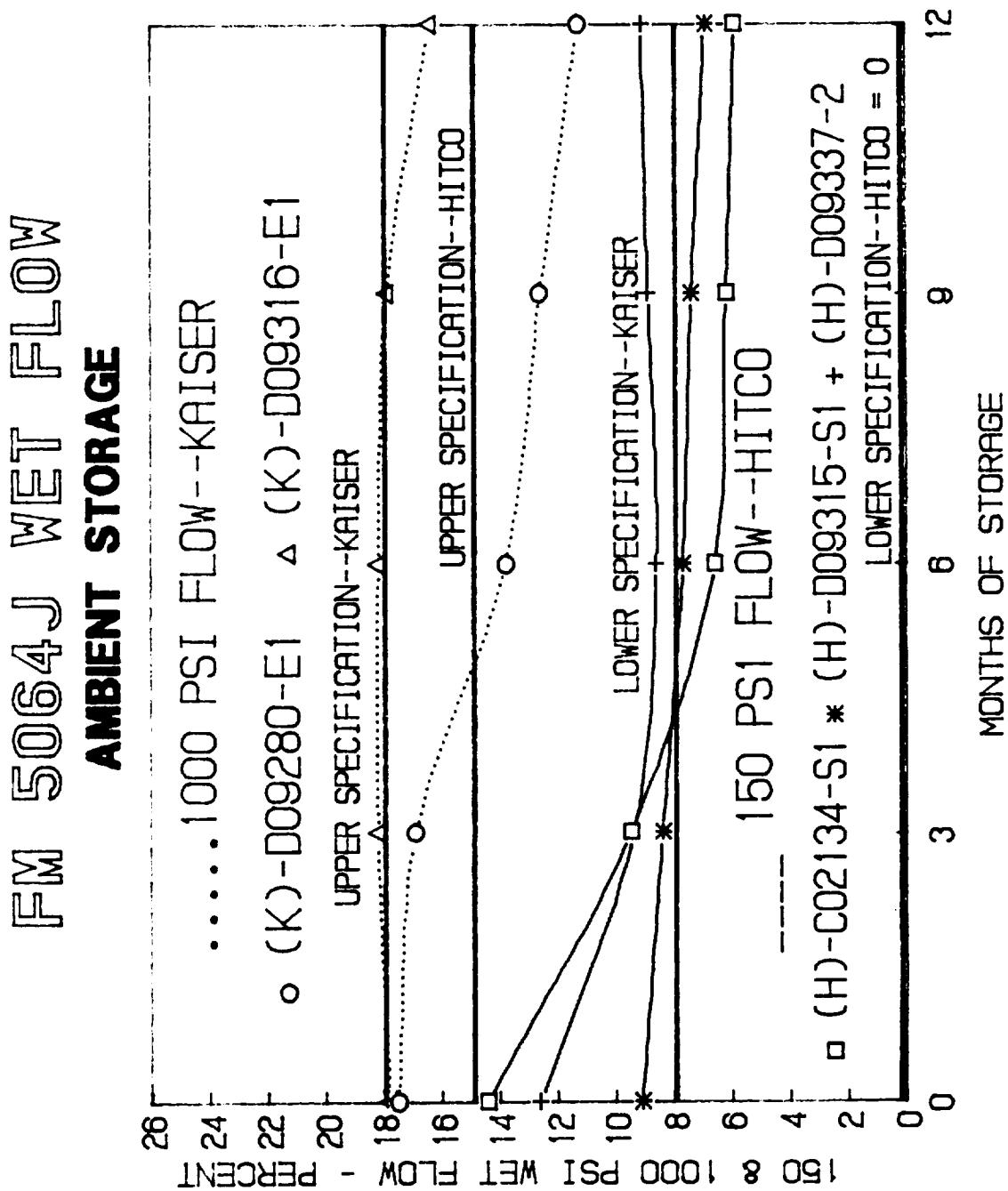


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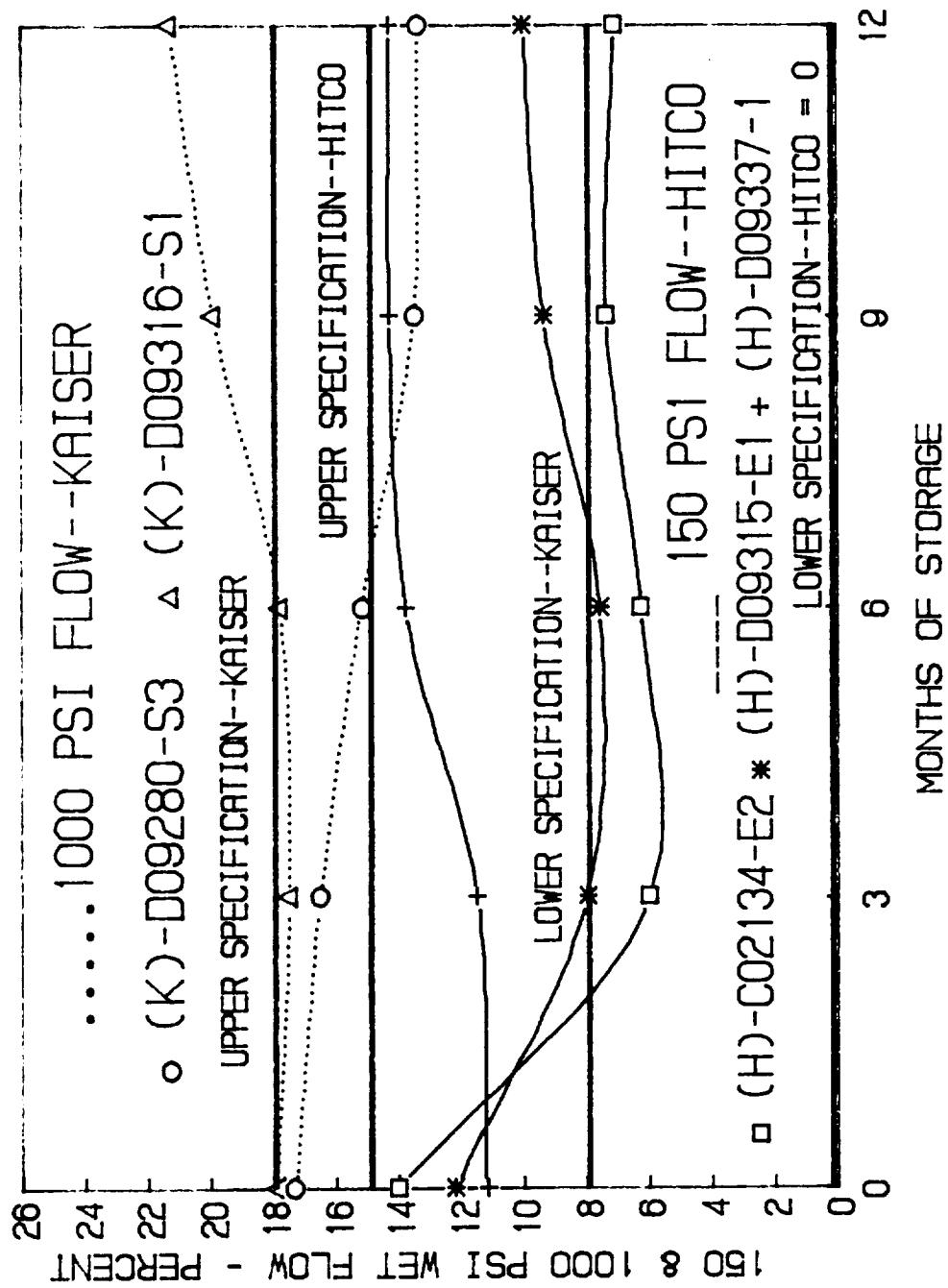


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40 DEGREE STORAGE**

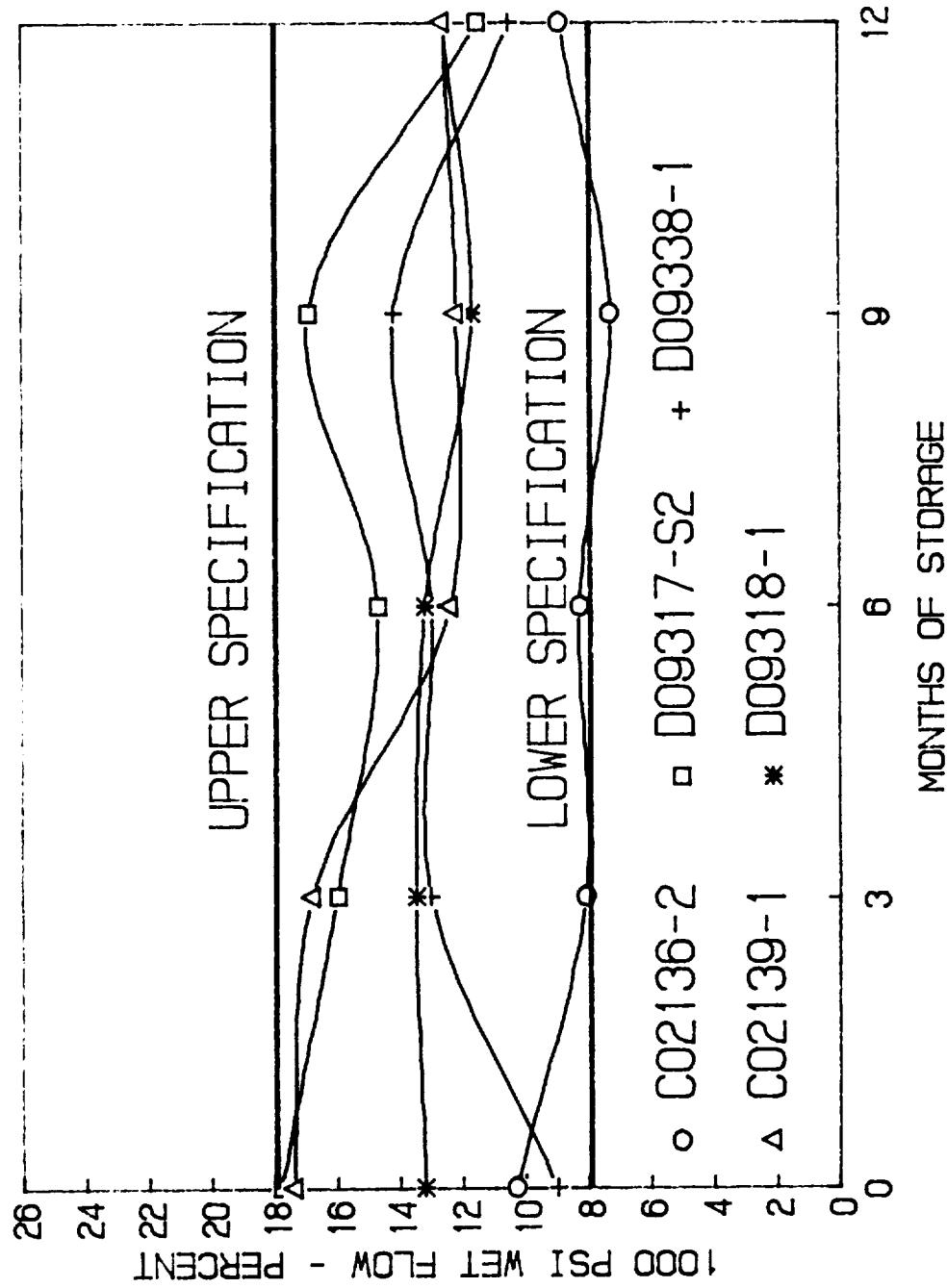




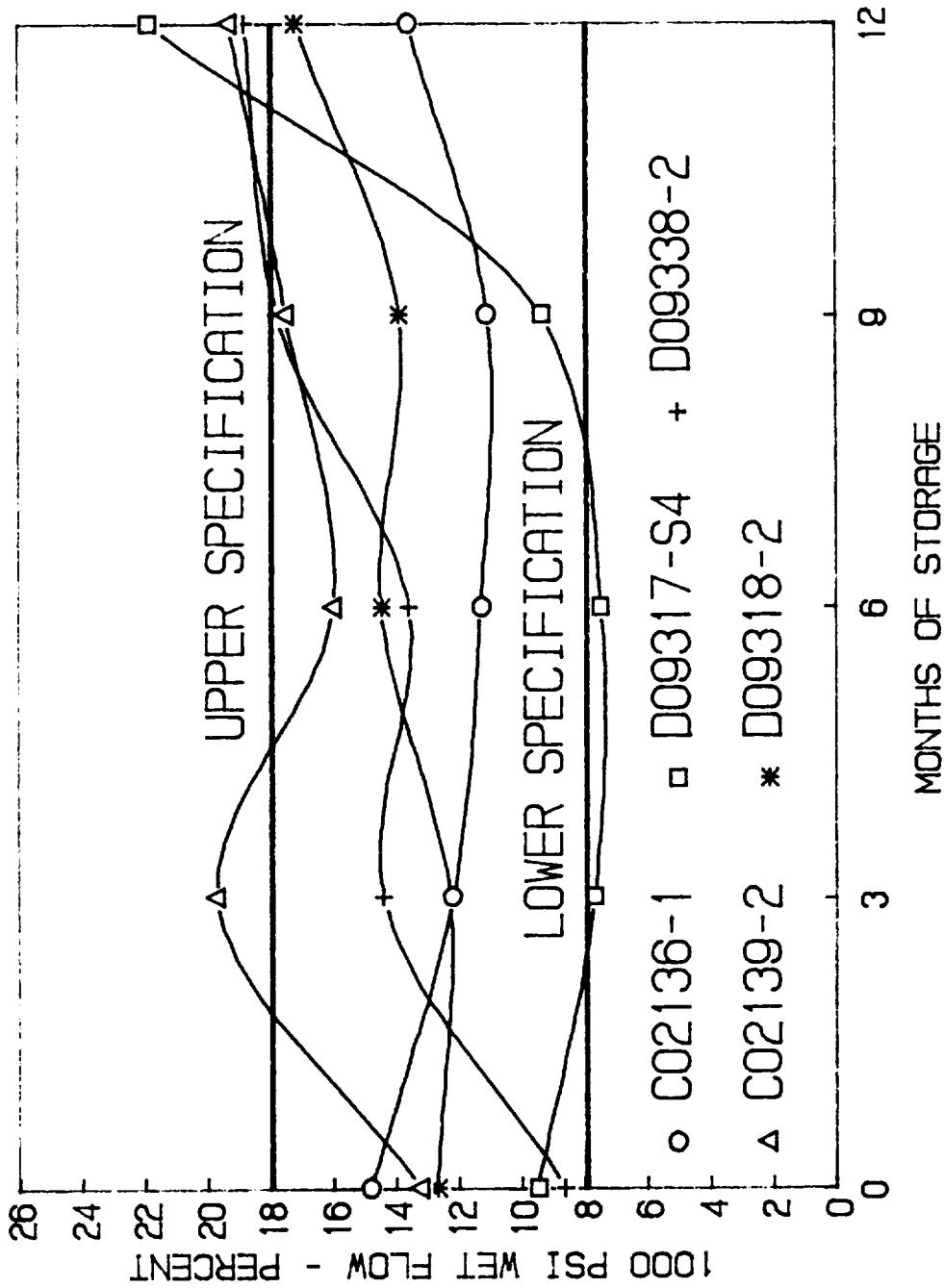
FM 50064 J WET FLOW
40 DEGREE STORAGE



**FM 5839 WET FLOW
AMBIENT STORAGE**



FM 5839 WET FLOW
40 DEGREE STORAGE



SHELF LIFE STUDY NAS8-36298

PERCENT VOLATILE

-----FM 5055B AMBIENT STORAGE-----

	LOT #1	LOT #2	LOT #3	LOT #4	LOT #5
MONTHS	D09256-E3	D09274-E5	C02133-S2	D09313-2	D09335-2
ORIG	4.3	4.4	4.1	4.5	4.3
3	6.1	5.3	4.7	5.3	4.4
6	6.1	5.9	5.0	5.4	4.7
9	5.7	6.1	4.8	5.2	4.7
12	6.0	5.5	5.2	5.2	4.8

===== PERCENT UP UP UP UP UP UP FM 5055B
CHANGE 39.5 25.0 26.8 15.6 11.6 23.7
AVERAGE UP

-----FM 5055B 40 DEGREE STORAGE-----

	LOT #1	LOT #2	LOT #3	LOT #4	LOT #5
MONTHS	D09256-S7	D09274-S2	C02133-S7	D09313-1	D09335-1
ORIG	4.1	4.3	4.1	4.3	4.3
3	4.8	5.5	4.6	4.8	4.7
6	6.1	6	4.8	6.1	4.6
9	6.1	6.6	5.7	5.4	4.8
12	7.4	6.3	6.3	5.8	5.2

=====
PERCENT UP UP UP UP UP UP FM 5055B
CHANGE 44.6 31.7 34.9 25.9 17.3 30.9
AVERAGE UP

PERCENT WET FLOW

-----FM 5055B AMBIENT STORAGE-----

	LOT #1	LOT #2	LOT #3	LOT #4	LOT #5
MONTHS	DO9256-E3	DO9274-E5	CO2133-S2	DO9313-2	DO9335-2
ORIG	19.8	19.5	17.8	21	20.2
3	18.1	15.2	19.2	18.9	14.3
6	18.4	11.8	18.2	19.3	14.6
9	17.4	16.1	12.9	17.1	15.9
12	17.2	17.2	15.9	18.2	14.2

===== PERCENT DOWN DOWN DOWN DOWN DOWN DOWN FM 5055B
CHANGE -13.1 -11.8 -10.7 -13.3 -29.7 -15.7
AVERAGE DOWN

-----FM 5055B 40 DEGREE STORAGE-----

	LOT #1	LOT #2	LOT #3	LOT #4	LOT #5
MONTHS	D09256-S7	D09274-S2	C02133-S7	D09313-1	D09335-1
ORIG	18	20	17.8	13.4	17.7
3	13	20.3	15.4	18.6	19.8
6	14.8	25.2	15.3	19.8	18
9	17.5	25.5	15.3	18.3	19.5
12	21.8	22.9	18.8	19.4	18.7

===== PERCENT UP UP UP UP UP UP FM 5055B
CHANGE 17.4 12.7 5.3 30.9 5.3 14.3
AVERAGE UP

PERCENT VOLATILE

-----FM 5834 AMBIENT STORAGE-----

MONTHS	LOT #1 D09255-2	LOT #2 D09275-S2	LOT #4 D09314-1	LOT #5 D09336-1
ORIG	4.6	5.5	4.3	4
3	4.2	4.1	4.3	4.2
6	3.8	3.4	4.2	3.9
9	3.5	3.3	4.1	3.7
12	3.6	3.8	3.6	3.6

PERCENT CHANGE	DOWN -21.7	DOWN -30.9	DOWN -16.3	DOWN -10.0	FM5834 -19.7
-------------------	---------------	---------------	---------------	---------------	-----------------

AVERAGE
DOWN

-----FM 5834 40 DEGREE STORAGE-----

MONTHS	LOT #1 D09255-1	LOT #2 D09275-S6	LOT #4 D09314-2	LOT #5 D09336-2
ORIG	4.5	5.5	3.7	4.2
3	4.1	5.4	4.2	4.1
6	4.2	4.5	4.6	4.8
9	4.2	4.6	4.3	4.6
12	4.6	4.9	4.4	5.2

PERCENT CHANGE	UP 2.2	DOWN -12.2	UP 15.9	UP 19.2	FM5834 6.3
-------------------	-----------	---------------	------------	------------	---------------

AVERAGE
UP

PERCENT WET FLOW

-----FM 5834 AMBIENT STORAGE-----

MONTHS	LOT #1 D09255-2	LOT #2 D09275-S2	LOT #4 D09314-1	LOT #5 D09336-1
ORIG	18.4	19.6	18.5	9.6
3	6.5	6.5	17.8	8.9
6	5.1	3.9	15.3	6.8
9	3.5	3.8	11.5	6.7
12	5.2	14.8	8.6	9.7

PERCENT CHANGE	DOWN -71.7	DOWN -24.5	DOWN -53.5	UP 1.0	FM5834 -37.2
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AVERAGE
DOWN

-----FM 5834 40 DEGREE STORAGE-----

MONTHS	LOT #1 D09255-1	LOT #2 D09275-S6	LOT #4 D09314-2	LOT #5 D09336-2
ORIG	17.9	18	10.6	9.4
3	10.3	19.7	11	8.6
6	8.7	25.6	13.6	15.7
9	9.5	13.9	11.8	15.2
12	11.2	15.5	13.2	15.9

PERCENT CHANGE	DOWN -59.8	DOWN -16.1	UP 19.7	UP 40.9	FM5834 -3.8
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AVERAGE
DOWN

PERCENT VOLATILE

-----FM 5064J AMBIENT STORAGE-----

MONTHS	LOT #1(H) C02134-S1	LOT #2(K) D09280-E1	LOT #4(H) D09315-S1	LOT #4(K) D09316-E1	LOT #5(H) D09337-2
ORIG	3.4	2.6	3.1	2.8	3.3
3	3.3	3.1	3.3	3	3.5
6	3	2.9	3.2	2.8	3.4
9	3	2.9	3.7	3.1	3.4
12	3	2.9	3.2	2.9	3.4

===== HITCO KAISER

PERCENT CHANGE	DOWN -11.8	UP 11.5	UP 3.2	UP 3.6	UP 3.0	FM 5064J -1.8	FM 5064J 7.6
						AVERAGE DOWN	AVERAGE UP

-----FM 5064J 40 DEGREE STORAGE-----

MONTHS	LOT #1(H) C02134-E2	LOT #2(K) D09280-S3	LOT #4(H) D09315-E1	LOT #4(K) D09316-S1	LOT #5(H) D09337-1
ORIG	2.9	2.5	3.2	2.8	3.3
3	3	3	3.4	3	3.6
6	2.8	2.8	3.5	2.8	3.6
9	3.1	2.7	3.8	3.4	3.8
12	3.3	2.9	3.8	3.4	4.1

===== HITCO KAISER

PERCENT CHANGE	UP 12.1	UP 13.8	UP 15.8	UP 17.6	UP 19.5	FM 5064J 15.8	FM 5064J 15.7
						AVERAGE UP	AVERAGE UP

PERCENT WET FLOW

-----FM 5064J AMBIENT STORAGE-----

MONTHS	LOT #1(H) C02134-S1	LOT #2(K) D09280-E1	LOT #4(H) D09315-S1	LOT #4(K) D09316-E1	LOT #5(H) D09337-2
ORIG	14.4	17.5	9.1	17.8	12.6
3	9.5	16.9	8.4	18.2	9.4
6	6.6	13.8	7.7	18.2	8.6
9	6.2	12.6	7.4	17.9	8.9
12	5.9	11.3	6.9	16.4	9.1

===== HITCO KAISER

PERCENT CHANGE	DOWN -59.0	DOWN -35.4	DOWN -24.2	DOWN -7.9	DOWN -27.8	FM 5064J -37.0	FM 5064J -21.6
						AVERAGE DOWN	AVERAGE DOWN

-----FM 5064J 40 DEGREE STORAGE-----

MONTHS	LOT #1(H) C02134-E2	LOT #2(K) D09280-S3	LOT #4(H) D09315-E1	LOT #4(K) D09316-S1	LOT #5(H) D09337-1
ORIG	14	17.3	12.2	17.9	11.2
3	6	16.5	8	17.5	11.5
6	6.3	15.2	7.6	17.8	13.8
9	7.4	13.5	9.4	19.9	14.3
12	7.1	13.4	10	21.3	14.3

===== HITCO KAISER

PERCENT CHANGE	DOWN -97.2	DOWN -29.1	DOWN -22.0	UP 16.0	UP 21.7	FM 5064J -32.5	FM 5064J -6.6
						AVERAGE DOWN	AVERAGE DOWN

PERCENT VOLATILE

-----FM 5839 AMBIENT STORAGE-----

	LOT #1 CO2136-2	LOT #2 D09318-1	LOT #3 CO2139-1	LOT #4 D09317-S2	LOT #5 D09338-1	
MONTHS						
ORIG	2.2	3.2	2.4	2.4	2.2	
3	2.8	2.7	2.7	2.9	2.5	
6	2.5	2.7	2.6	3	2.7	
9	2.6	2.8	2.7	3.1	2.6	
12	2.6	2.7	2.7	2.9	2.7	
=====	=====	=====	=====	=====	=====	
PERCENT CHANGE	UP 18.2	DOWN -15.6	UP 12.5	UP 20.8	UP 22.7	FM5839 11.7
AVERAGE	UP	UP	UP	UP	UP	UP

-----FM 5839 40 DEGREE STORAGE-----

	LOT #1 CO2136-1	LOT #2 D09318-2	LOT #3 CO2139-2	LOT #4 D09317-S4	LOT #5 D09338-2	
MONTHS						
ORIG	2.2	2.5	2.8	2.3	2.2	
3	3	2.6	3	2.5	2.8	
6	2.5	2.9	2.6	2.6	2.8	
9	2.9	3.1	3	3	2.9	
12	2.8	3.4	2.9	3.3	3.1	
=====	=====	=====	=====	=====	=====	
PERCENT CHANGE	UP 21.4	UP 26.5	UP 3.4	UP 30.3	UP 29.0	FM5839 22.1
AVERAGE	UP	UP	UP	UP	UP	UP

PERCENT WET FLOW

-----FM 5839 AMBIENT STORAGE-----

	LOT #1	LOT #2	LOT #3	LOT #4	LOT #5
MONTHS	C02136-2	D09318-1	C02139-1	D09317-S2	D09338-1
ORIG	10.3	13.2	17.4	17.8	9
3	8.1	13.5	16.8	16	13
6	8.3	13.2	12.4	14.7	13
9	7.3	11.7	12.2	16.9	14.2
12	8.9	12.6	12.6	11.5	10.5

PERCENT	DOWN	DOWN	DOWN	DOWN	UP	FM5839
CHANGE	-13.6	-4.5	-27.6	-35.4	16.7	-12.9

AVERAGE
DOWN

-----FM 5839 40 DEGREE STORAGE-----

	LOT #1	LOT #2	LOT #3	LOT #4	LOT #5
MONTHS	C02136-1	D09318-2	C02139-2	D09317-S4	D09338-2
ORIG	14.8	12.7	13.2	9.5	8.6
3	12.2	12.3	19.7	7.7	14.4
6	11.3	14.5	16	7.5	13.6
9	11.1	13.9	17.5	9.4	17.8
12	13.6	17.2	19.3	21.5	18.8

PERCENT	DOWN	UP	UP	UP	UP	FM5839
CHANGE	-8.8	26.2	31.6	55.8	54.3	31.8

AVERAGE
UP